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ABSTRACT

The York University Biology Achievement Test (YUBAT) and its use in the Metropolitan Toronto (Ontario) schools were examined. YUBAT was compared with the province's grade 13 biology curriculum guideline, and with representative courses and textbooks. This analysis revealed much similarity between the test, courses, and two textbooks used. The cognitive level of YUBAT was considerably lower than the level specified in the guideline or the achievement level reported by teachers. It was recommended that test aims be specified so that reliability and validity could be estimated. Data were also collected from 67 teachers who had used the test. They valued the test as a measure of student achievement, but not as a measure of school curriculum or effective teaching. They felt that YUBAT would influence course content, but not teaching methods or evaluation methods. Most recommended that the test be continued on a voluntary basis. Principals were more supportive of test use than supervisory officials. All sources generally concluded that the test permitted recognition of outstanding student achievement, but did not achieve the goal of greater between-school uniformity in the grade 13 biology curriculum. Questionnaire items and data are appended. (Author/GDC)

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A Case Study of the Relationship between Curriculum Policy, School Program, and External Testing

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Abstract

The purpose of the study was to examine and assess the York University Biology Achievement Test and its use in Metropolitan Toronto schools.

In accordance with the contract terms, the Test was examined and assessed in comparison with the provincial grade 13 Biology curriculum guideline, with representative courses of study, and with representative textbooks. To make the comparison three analytical frameworks were derived from the guideline: one using seven content units, the second using six selected content emphases, and the third using five cognitive levels. Information from the guideline and textbooks was collected by analysis, and from the courses of study by solicited course outlines and survey instrument. The results of the comparison were that for seven content units and the six selected emphases there is a great deal of similarity among the Test, representative courses of study, and two of the textbooks. The cognitive level of the Test is considerably lower than the level teachers reportedly achieve in their courses of study and it is lower than the level emphasized in the guideline. In addition, the Test was appraised for its test characteristics. The results were that Test aims need to be specified against which reliability and validity estimates can be made.

Teacher opinion was surveyed in October, 1977, on the value of the Test, its influence on the curriculum, and its use in schools. Information was collected by survey instrument from 67 teachers who had used the Test. The results were that teachers valued the Test's test characteristics and the Test as a measure of student achievement. Teachers generally did not value the Test as a measure of teacher effectiveness nor of a school's program in Biology. In terms of the influence of the Test on the

curriculum, teachers' opinions were that course content was likely to be influenced, but that teaching methods were unlikely to be influenced, and assessment methods even less so. Most teachers recommended that the Test continue to be used on a voluntary basis.

The extent to which the aims of the Test are being achieved was assessed by interviewing the teachers and York University faculty who developed the Test, and by analysing York University records of the test development period. Information from teacher users was obtained in the survey instrument. All sources generally say that the aim of permitting recognition of outstanding achievement by grade 13 Biology students has been accomplished. All sources generally say that the aim of influencing grade 13 Biology curriculum to provide greater uniformity among the schools has not been achieved.

The opinions of principals and supervisory officers on the current and potential value of the Test program were collected by telephone interview. Principals in whose schools the Test was administered appeared to favour the use of achievement tests, while supervisory officers in whose jurisdictions the Test was administered viewed achievement testing with caution.

Acknowledgments

The research team is grateful for the cooperation and assistance of Dr. Ken Davey and Mr. Douglas Farquhar of York University, and of teachers, principals, and supervisory officers in the East York, Etobicoke, North York, Peel, Scarborough, Toronto, York Borough, and York County Boards of Education. The helpful advice of Ministry of Education officials was also appreciated. Acknowledgments are made to Mr. Bill Postl, Mrs. Gila Hanna, and Mr. Larry Bekich for their assistance at various stages of the research. Finally, a big thank you goes to Miss Sally Praskey and Mrs. Dorothy Ainsworth for their continued and skilful secretarial support.

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Introduction

The York University Biology Achievement Test[1] was initiated in the fall of 1974 by a group of North York Board of Education high school teachers who felt a need for an external "measuring stick." For assistance, they turned to Dr. K. Davey, Chairman of the Biology Department at York University. A test development committee was set up, composed of five Biology teachers and two Biology faculty members. The intention was to develop a biology test similar to the *Chem 13 News* Research Assistantship Examination administered by the University of Waterloo.[2] In a memorandum by Dr. Davey in January 1975,[3] the objectives of the Test were stated as follows:

(1) The Test will operate as a tool for improving uniformity of the curricula in Biology among individual schools.

(2) The Test might allow individual schools to assess their effectiveness in teaching certain areas of Biology.

(3) The Test would permit recognition of outstanding achievement by individual students.

(4) Achievement on the Test might be related to exemption from some course requirements at university level.

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[1] Shortened to YUBAT throughout this report.

[2] K. G. Davey, Memorandum to Dean, Faculty of Science (October 30, 1974), p. 1.

[3] K. G. Davey, Memorandum to Test Development Committee and Dean, Faculty of Science (January 2, 1975), p. 1.

The Test was administered in 1975, 1976, and 1977 to 1120, 612, and 1057 students respectively. All told, 108 schools and at least 108 teachers participated in its administration. The precise number of teachers is unknown because York University records indicate only the YUBAT contact teacher in each school. Frequently this teacher distributed the Tests for administration by his or her colleagues.

Beginning in 1976, the Ontario Ministry of Education engaged in correspondence and meetings with York University to inquire into the use of the Test. An outcome of this consultation was an agreement that a research project be mounted to assess the Test.

The central purposes of the research study were to assess the success of YUBAT in achieving its purposes and to determine the possible influences of YUBAT on school curriculum. Four tasks defined the scope of research:

(1) to examine and assess YUBAT in the light of the provincial grade 13 Biology curriculum guideline, representative courses of study, and representative textbooks;

(2) to survey teacher opinion on the value of the Test, on its influence on curriculum, and on its use in the schools;

(3) to assess the extent to which the aims of the Test are being achieved; and

(4) to assess the value of the Test program in the opinions of principals and supervisory officers.

Methodology

Information in this study was collected primarily by analysis, interview, and survey instrument. In addition, other information was volunteered by school and York University personnel through their own records and meetings.

THE ANALYSIS OF YUBAT

The Ministry of Education Biology curriculum guideline, 1969,[1] served as the reference standard for assessing YUBAT. The guideline specifies seven content units, three approaches to biology, and, to a certain extent, the cognitive level of goals to be achieved. The seven unit outlines became the framework for content analysis of YUBAT and permitted comparison of YUBAT with textbooks and courses of study. No attempt was made to compare biological approaches, although six content areas that tend to cut across the outline of units were selected for analysis and comparison. Bloom's taxonomy of cognitive objectives[2] was used to construct a grid for comparing the cognitive level of student achievement aimed at by teachers with YUBAT items.

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[1] Ontario Department of Education, *Biology: Grade 13* (Toronto, 1969).

[2] Benjamin S. Bloom, ed., *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook 1: Cognitive Domain* (New York: D. McKay Co., 1956), pp. 186-193.

Guideline Unit Analysis Framework

The framework for analysis based on the outline of units in the Ministry of Education Biology curriculum guideline is as follows:

Unit 1: Characteristics of Living Things
1. Movement
2. Irritability
3. Reproduction
4. Metabolism

Unit 2: Cells
1. Structure
2. Physical properties
3. Mitosis
4. Added category[1] (chemical properties, functions)

Unit 3: Organisms
1. Study of animals[2] (Zoology)
1.1 Digestion
1.2 Circulation
1.3 Respiration
1.4 Excretion
1.5 Locomotion
1.6 Reproduction
1.7 Coordination
1.8 Added category (development, homeostasis, biochemistry, tissues)

2. Study of plants (Botany)
2.1 Supporting system
2.2 Anchorage
2.3 Absorption
2.4 Conducting system
2.5 Growth
2.6 Gas exchange
2.7 Photosynthesis
2.8 Food storage
2.9 Reproduction
2.10 Coordination

Unit 4: Classification of Organisms
1. History
2. Principles
3. Use of a taxonomic key

Unit 5: Interdependence of Organisms
1. Photosynthesis
2. Food chain
3. Communities
4. Population size
5. Special relationships
6. Influence of man

---

[1]Some categories were added to permit a complete item classification.

[2]Unit subheadings were modified in several cases to permit items to be classified which would otherwise have required a new unit or subhead.

Unit 6: Heredity
1. Reproduction
2. Meiosis
3. Added category (biochemical basis, laws)

Unit 7: Evolution
1. Darwin's theory and others
2. Mechanics
3. Application
4. Added category (evidence)

Selected Content Emphases

The grade 13 Biology guideline specifies three possible teaching approaches: homeostatic, ecological, and principle. It was decided that neither YUBAT nor teacher programs could be reliably analysed for their approach, and this orientation of the guideline was omitted from the study. Nevertheless, both Homeostasis and Biochemistry can be identified as content areas and approaches that cut across the unit outlines, and these, along with four other content areas, were used to summarize data obtained by the application of the Guideline Analysis Framework. The six selected content emphases are:

Biochemistry,
Ratio of Zoology items to Botany items,
Genetics,
Scientific Method,
Ecology, and
Homeostasis

Cognitive Level Analysis Framework

In its "Foreword," the 1969 grade 13 Biology guideline emphasizes cognitive goals common to all approaches. Two such goals are "to provide intellectual stimulation" and to "acquire a more penetrating understanding of the nature of life."[1] To examine the level of cognitive skills for purposes of this study, a five-point taxonomy based on Bloom's *Taxonomy of Educational Objectives*[2] was used. In ascending order, along with their summary definitions, these skills are:

---

[1]Ontario Department of Education, *Biology: Grade 13*, p. 5.

[2]Bloom, ed., *Taxonomy*, pp. 186-193.

knowledge,
understanding,
application,
synthesis, and
evaluation.

Knowledge: involves little more than bringing to mind the appropriate material. For instance, YUBAT item 2:

"Organ of Corti" is found in

(a) inner ear
(b) middle ear
(c) the nose
(d) the eye
(e) church

Understanding: derives from Bloom's "comprehension" category. In answering this type of item, the respondent makes use of the material or idea being communicated without necessarily relating it to other material. For example, YUBAT item 1:

The ability of a cell to control the amount of water in it is an example of

(a) osmosis
(b) oxidation
(c) diffusion
(d) absorption
(e) homeostasis

Application: concerns the remembering and applying of abstractions in particular and concrete situations. For instance, YUBAT item 14:

In the kidney of a small mammal living in the desert, which of the following structures might be expected to be well developed in comparison with other mammals living in more humid locations?

(a) convoluted tubules
(b) urinary bladder
(c) ureter
(d) glomerulus
(e) all four of the structures mentioned

Synthesis: concerns the putting together of elements and parts so as to form a whole. For instance, YUBAT item 156:

A phenotype is to a genotype as

(a) a homozygote is to a heterozygote
(b) a translation is to a transcription
(c) a building is to a blueprint
(d) a chromosome is to a cell
(e) an organism is to an embryo

Evaluation: involves judgments using a standard of appraisal.

For instance, YUBAT item 43:

Which of the main items in Darwin's theory of Evolution (listed below) are conclusions of Darwin's theory rather than observations?

(1) Those varieties of an organism best fitted for the environment will tend to survive and reproduce.
(2) The numbers of offspring produced by any organism are more than those required to maintain the population.
(3) There is competition of some sort between members of a population for food, breeding areas, etc.
(4) In any population of organisms there are many variations which are passed on to offspring.
(5) The numbers of most organisms tend to remain relatively constant over long periods of time.

(a) 2 & 4
(b) 3 & 5
(c) 2 & 3
(d) 1 & 3
(e) 4 & 5

There are difficulties in applying the cognitive taxonomy to the classification of test items where the exact nature of instruction received by each student is not known. A knowledge item for one student may, for example, require synthesis by another student taught in a different way. Accordingly, the precise classification of items should be treated cautiously.

Analytic Procedures

Following the analytic outlines above, each YUBAT item was classified in three ways: (1) according to content as specified in the Guideline Unit Analysis Framework, (2) according to one of the six topics specified in the selected content emphases, and (3) according to cognitive level. The classification was done by two raters, Dr. Connelly and Dr. Ben-Peretz, both of whom have taught Biology at the school, college, and teacher education levels. Reliability was achieved by the raters jointly classifying one half of the items and discussing at length alternate possible classifications of individual items. The remaining items were divided equally among the two raters for classification. Discussion occurred for any item in question and for the overall classification. In addition, York University's item classification was obtained and was considered in deliberations about the classification of individual items. In this way, validity and reliability sufficient for the purposes of the study were achieved.

Nevertheless, the classification procedures do not permit a statistical estimate of reliability, nor do they carry any more validity than can be attributed to the qualifications of the raters.

YUBAT Reliability

YUBAT reliability was estimated by appraising the developmental and post-test analysis procedures used by York University. Details about these procedures were obtained from a 1975 report[1] by D. Farquhar, a member of the York Biology faculty, and from interviews with Dr. Davey and Mr. Farquhar. The appraisal was made according to the technical recommendations for achievement tests of the Committee on Test Standards, AERA.[2] These recommendations specify the following procedures:

1) determining the objectives to be measured;
2) selecting suitable methods and techniques;
3) developing a pool of items;
4) having items reviewed by qualified persons;
5) administering experimental forms; and
6) selecting items for the final form.

REPRESENTATIVE COURSES OF STUDY

The original contract called for an assessment of the YUBAT "in the light of. . .representative courses of study." Two sources of information were used for this assessment. Printed materials outlining the grade 13 Biology courses of study were obtained from twelve schools in which YUBAT was administered. In addition, information on courses of study was collected in Section III of the survey instrument. Here, teachers were requested to describe their grade 13 Biology programs according to the Guideline Unit Analysis Framework derived from the 1969 Department of Education grade 13 Biology curriculum guideline.

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[1] D. Farquhar, *York Achievement Test in Biology* (Toronto: York University Informal Report, 1975).

[2] American Educational Research Association and National Council on Measurements Used in Education, *Technical Recommendations for Achievement Tests* (Washington, D.C.: National Education Association, 1955).

Printed Course Outlines

Printed grade 13 Biology course outlines were obtained from the following twelve schools: North Toronto Collegiate Institute, David and Mary Thomson Collegiate Institute, Agincourt Collegiate Institute, Sir Wilfrid Laurier Collegiate Institute, Newtonbrook Secondary School, Bramalea Secondary School, Woodlands Secondary School, Earl Haig Collegiate Institute, Vaughan Road Collegiate Institute, C.W. Jefferys Secondary School, Weston Collegiate Institute, and Parkside Collegiate Institute.

The printed course outlines varied considerably in detail, and ranged in length from two pages to two rather thick student handbooks. One outline was received in the form of a handwritten letter to the investigators. The information contained in these outlines was, for the most part, a list of content topics. In some cases the number of periods or lessons devoted to each topic was given. In addition, some outlines contained textbook chapter references. Most of the program outlines omitted statements about goals, methodology, influences on program planning, and evaluation.

It was decided that the printed course outlines were too limited and variable when compared to the survey instrument section on program to warrant detailed analysis. However, because the instrument did not yield much information on teacher emphasis on Homeostasis and only sketchy information on Biochemistry, the printed outlines were analysed for their relative emphases on these two topics.

Survey Instrument

Since survey instrument responses were computerized, all teachers who had used YUBAT were surveyed on program, rather than the ten teachers as originally proposed. The program question areas, along with the applicable survey item numbers, are presented in Table 1.

TABLE 1

Classification of Survey Instrument Items
on Characteristics of Teachers' Programs

Sub-Topics	Item No.
Goals	12.1 - 12.8
Content of grade 13 Biology	40.1 - 40.57, 41
Cognitive level of instruction	40.1 - 40.57, 41
Course development	9.1 - 9.11
Prerequisites	10, 11
Resources	13.1 - 13.8, 14
Evaluation of student progress	15 - 17, 19.1 - 19.13

REPRESENTATIVE BIOLOGY TEXTBOOKS

The contract called for an assessment of YUBAT in terms of representative grade 13 Biology textbooks. Three books - by Penny & Waern, Galbraith & Wilson, and Moore *et al.* - were selected from Circular 14.[1]

(1) Penny, D. A., and Waern, R. *Biology: An Introduction to Aspects of Modern Biological Science.* Toronto: Sir Isaac Pitman (Canada) Limited, 1965.

(2) Galbraith, D. I., and Wilson, D. G. *Biological Science: Principles and Patterns of Life.* Toronto: Holt, Rinehart and Winston, 1966.

(3) Moore, J. A., *et al. Biological Science: An Inquiry into Life.* 1st ed. New York: Harcourt Brace Jovanovich, Inc., 1963. (Known also as B.S.C.S. - Yellow).

Surveyed teachers were asked to identify texts used, and it appears that about half of the surveyed teachers use one of the books chosen (see item 14 of the survey instrument).

Textbook content was classified according to the Guideline Unit Analysis Framework and according to the six selected content emphases,

[1]Ontario Ministry of Education, *Circular 14 Textbooks* (Toronto, 1977), p. 115.

by page listing. Pages were counted and converted to a percentage of the total book devoted to the particular unit and sub-unit. Textbook analysis was conducted by Dr. Ben-Peretz, selectively tested for accuracy by Dr. Connelly, and reclassified by Dr. Ben-Peretz. No attempt was made to count partial pages or to separate multiple sub-units treated on a page. Nevertheless, it is deemed that the reliability of textbook topical analysis is appropriate to the purposes of the study.

TEACHER USER OPINION

The contract specified that teacher opinion on the value of the Test, its influence on curriculum, and its use in the schools be assessed. That was accomplished by the development of a survey instrument which was circulated to all teachers who, according to records at York University, had used the Test.

In addition, as noted above in the section on representative courses of study, the instrument was used to gather program information. Additional teacher opinion was obtained through interviews with YUBAT development teachers. This information is primarily of value in determining the purposes of YUBAT and is, accordingly, described later in the appropriate section.

The Survey Instrument

Development: A preliminary draft of the instrument was developed by the investigators. This draft version was administered to three teachers, each of whom was interviewed for about an hour and a half following administration of the instrument. The three teachers were asked to make notes and comments on the instrument. The interviews were designed to review this information and also to determine, through a detailed investigation of teachers' use of YUBAT, whether major areas had been omitted in the instrument. In addition, Ministry officials were consulted about the draft version to ensure that major areas had not been omitted. Suggestions and revisions from all of these sources were incorporated in the final version of the instrument.

Survey Procedure: One hundred and eight copies of the survey instrument were mailed. Survey instruments were numbered to identify teachers who did not return their copies. Each teacher also received a postage-paid return envelope and a covering letter which explained the purposes of the survey and which requested a ten-day turn-around period. Courtesy copies of the instrument were sent to Dr. Davey and Mr. Farquhar. Three weeks after the first mailing, those copies not yet received were identified and reminder letters were sent out. Sixty-seven usable copies were ultimately received. This represents only about two-thirds of the total population and presents a possible problem with the validity of the sample. Ideally, non-respondents would have been sampled to test the representativeness of those who did respond. For purposes of this study, however, the procedure was not followed, since the original contract was concerned more with the range of responses than with a precise statistical breakdown of users.

Classification of Survey Instrument Items: Table 2 classifies instrument question items according to topic, sub-topic, and question item number.

Data Analysis: The data were computerized and simple frequency (f) and percentage of respondents (%) for each response category were tabulated. The complete set of tabulated data for both the teacher opinion and program information parts is presented in Appendix A.

ACHIEVEMENT OF YUBAT AIMS

Identification of YUBAT Aims

There is no definitive statement of the aims for YUBAT and, accordingly, there is no simple criterion for judging the extent to which the Test is achieving its purposes. Fortunately Dr. K. Davey had maintained a comprehensive file on YUBAT since its inception, and this was kindly given to the investigators. This file, along with interviews with Dr. Davey and Mr. Farquhar and with YUBAT development teachers, became the basis for identifying a variety of possible reasons for using YUBAT. The complete list is given in the survey instrument, item 35.1-35.17, and is reproduced below on page 15.

TABLE 2

Classification of Teacher Opinion Items in the Survey Instrument

Topic	Sub-topics	Item No.
Teacher perception of the influence of YUBAT on their grade 13 Biology programs	Course planning.	9.10, 20.1 - 20.3
	Preparation of students. . . .	23, 24, 25
	Principal requests for special preparation	36.1 - 36.3
	Student requests for special preparation	37.1 - 37.3
	Testing.	38
Teacher perception of the influence of YUBAT on students	Student enthusiasm for	32
	Student receipt of test scores.	33
	Future interest in biology . .	34
	Standardized testing in general	22, 30
Teacher reasons for using YUBAT	Student reasons.	35.1, .2, .3, .4, .6, .9, .11, .12, .13, .14, .16
	Teacher reasons.	37.7
	Program reasons.	35.5, 35.8, 35.10, 35.15
Teacher satisfaction with YUBAT	Test characteristics	27.1 - 27.7
	Student achievement.	27.8
	Teacher effectiveness.	27.9
	School program	27.10
	General.	26
Teacher views on the application of YUBAT	. . . . .	28, 29, 30
Teacher views on standardized testing in general	Influence on program	20.1 - 20.3, 21.1, 21.3
	Student benefit.	22
	Testing practices.	30
	Standardized test preparation	31
Characteristics of teachers' program	Goals.	12.1 - 12.18
	Content of grade 13 Biology	40.1 - 40.57, 41
	Cognitive level of instruction	40.1 - 40.57, 41
	Course development	9.1 - 9.11
	Prerequisites.	10, 11
	Resources.	13.1 - 13.8, 14
	Evaluation of student progress.	15, 16, 17, 19.1 - 19.13

York University Records

A chronological chart based on file memoranda was developed to trace YUBAT aims appearing in these files. The aims so obtained are primarily from the point of view of York University. Records on school and teacher users, Test item classification, and statistical analysis of preliminary test administration were also made available to the investigators.

York University Biology Faculty Interviews

In order to identify York University's current view on the aims of YUBAT and also to identify the extent to which York's aims for YUBAT have been achieved, Dr. Davey and Mr. Farquhar were interviewed together in an unstructured setting on two separate occasions. On both occasions time was generously given.[1]

Teacher Interviews - YUBAT Development Committee Members

Four teachers from the YUBAT development committee were interviewed by telephone. It was not possible to obtain an interview with the fifth teacher within the time constraints imposed by the study. Eight questions were asked:

(1) What were the reasons you had for getting involved in initiating the Test?

(2) What goals did you anticipate would be achieved by the Test?

(3) Would you supply details about how you used the Test?

(4) For which cognitive skills were you testing?

(5) What is your opinion about the success and/or failure of the Test?

(6) Has your use of the Test any implications for your own program?

(7) What are your general views about testing?

(8) Have you any other comments to make?

Teacher User Opinion on Possible Reasons for Using YUBAT

Based on York University records and interviews with teachers and York University faculty, seventeen possible reasons for using YUBAT were identified. Teachers were asked to rate these reasons in the survey

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[1]The investigators note that York University personnel were generous with their time and their help in supplying long buried information.

instrument, item 35, found in Appendix A, pp. 76-78. The seventeen reasons are:

35.1 measures the level of achievement for individual students;

35.2 helps in guiding students into appropriate post-secondary programs;

35.3 compares your students' scores with those in other schools;

35.4 helps students gain a better understanding of their strengths and weaknesses;

35.5 helps determine the significance to your grade 13 Biology program;

35.6 a valid indicator of student learning;

35.7 a valid indicator of teacher competence;

35.8 helps you plan your course;

35.9 a diagnostic instrument for your students;

35.10 serves to identify strengths and weaknesses in your grade 13 Biology course;

35.11 can identify outstanding achievement at least as well or better than you can;

35.12 serves to select scholarship students in Biology;

35.13 provides a high level challenge to your students;

35.14 serves to encourage young talent in Biology;

35.15 serves as a prototype to prepare you for a return to a province-wide uniform Biology program;

35.16 provides for the possibility of some of your students gaining advanced admission status at York University;

35.17 no special reason but saw no harm in using the Test.

PRINCIPAL AND SUPERVISORY OFFICER OPINION

Telephone interviews were conducted with seven principals and six supervisory officers in whose schools and jurisdiction YUBAT was administered. In all cases a formal appointment was scheduled in advance and the interviewee was told of the general purpose of the interview. Two general questions were asked:

(1) How valuable or otherwise is YUBAT?

(2) What is the potential value of YUBAT?

Twice a supervisory officer designated a science coordinator to be interviewed instead. This is indicated in the data section by reference to, for instance, "Coordinator B." Interview results are summarized in paragraph form. Detailed reports of each interview are available upon request.

VOLUNTARY SOURCES

People contacted in the course of the research sometimes very kindly offered information they had gathered on YUBAT usage. Information from two science coordinators is included in the report.

In addition, one science coordinator issued an invitation to the investigators to attend a meeting of Biology department heads in order to ask two general discussion questions:

(1) How valuable or otherwise is YUBAT?

(2) What is the potential of YUBAT?

The heads agreed that notes could be taken and a summary included, with confidentiality, in the research report.

Results and Discussion

ANALYSIS OF YUBAT

Guideline Unit Emphasis in YUBAT

Complete results of the classification of YUBAT items according to the Guideline Unit Analysis Framework are presented in Appendix Table 1. A summary of the data is presented below in Table 3. Appendix Table 2 gives York University's classification of YUBAT items.

TABLE 3

Summary of the Guideline Unit Analysis of YUBAT[1]

Content areas		No. of Entries	% of Total Entries
Unit 1:	Characteristics of Living Things	5	2
Unit 2:	Cells	56	24
Unit 3:	Organisms		
	(A) Zoology	71	31
	(B) Botany	23	10
		94	41
Unit 4:	Classification	14	6
Unit 5:	Interdependence	18	8
Unit 6:	Heredity	31	13
Unit 7:	Evolution	13	6
	Total:	231	100

[1]The number of entries (N=231) exceeds the number of YUBAT items (N=212) owing to the cross-classification of certain items.

Unit 3, Organisms, is the most heavily tested area in YUBAT, with Zoology exceeding Botany in a ratio of about 3:1. About a quarter of the Test is on Cells and about a sixth of the Test is on Heredity. Less than a tenth of the Test is on each of Evolution, Classification, Interdependence, and Characteristics of Living Things. Altogether these last four units make up less than a quarter of the Test.

Four sub-units listed in the grade 13 Biology guideline -- irritability, history of classification, application, and the influence of man -- are not tested at all in YUBAT (Appendix Table 1). An additional seven sub-units are tested by only one item, and twenty sub-units out of a total of 42 are tested by three or fewer items.

It should be recalled that the Guideline Unit Analysis Framework contains sub-units listed as "added category" which do not appear in the Biology guideline. These added categories were constructed in order to unify items not readily placed in the guideline categories. All told, 73 entries, almost a third of the Test items, fall in the added categories. In effect, these items represent an addition to the guideline's suggested content.

York University's classification scheme for YUBAT items differs from that used in the present study. Nevertheless, where possible, cross-checks with York's classification were made. In some cases the investigators differed with York's classification of a given item but, on the whole, the two classifications support one another. For example, York's Zoology to Botany ratio is close to 3:1 and both systems list fourteen items under Classification (called "taxonomy" by York).

Selected Content Emphases in YUBAT

The item classification according to the six selected content areas is presented in Appendix Table 3. This information is summarized below in Table 4.

TABLE 4

Summary of Six Selected Content Emphases in YUBAT

Content Emphasis	Number of Entries	Percentage of Total Entries
Biochemistry	76	36
Ratio of Zoology to Botany	94:34	2.76:1
Genetics	30	14
Scientific Method	16	8
Ecology	9	4
Homeostasis	19	9

Approximately one-third of YUBAT items are Biochemistry oriented. The ratio of Zoology to Botany items is approximately 3:1. A little over 10% of the items are on Genetics and less than 10% of the items test each of Scientific Method, Ecology, and Homeostasis. York University's estimate of their emphases on Biochemistry and Homeostasis is slightly lower and, for Ecology, is slightly higher (Appendix Table 2). The areas of Scientific Method tested are limited to the use of the microscope (items 89, 90, 97, 101, 102, 103, 159, 160, 161, 162, 178, 179), and to the use of control in experiments (item 182).

Cognitive Level of YUBAT

The classification of YUBAT items according to the Cognitive Level Analysis Framework is presented in Appendix Table 3. A summary of the data is presented below in Table 5. YUBAT is heavily weighted toward lower-level cognitive skills; the proportion of items measuring lower-level skills ranges from approximately 60% to approximately 80%, depending on the definition of "lower and higher cognitive level." The percentage of total entries steadily decreases from 59% to 1% as increasing congitive level is measured.

TABLE 5

Summary of Cognitive Level Analysis of YUBAT[1]

Cognitive Level (from Bloom, ed.)	Number of Items	Percent of Total Items	Lower vs. Higher Cognitive Level	
			A(%)*	B(%)*
Evaluation	2	1	41	18
Synthesis	11	5		
Application	26	12		
Understanding	49	23	59	82
Knowledge	124	59		
	212	100	100	100

*Definition A, Knowledge compared with all other levels, is the simplest separation of lower from higher mental processes. Definition B, Knowledge and Understanding compared with all other levels, is based on the fact that understanding as it is treated in Bloom may be considered a lower-order cognitive skill.

Reliability of YUBAT

The reliability appraisal[1] of YUBAT is organized according to the six items listed in the AERA standards.[2]

Determining the Objectives to Be Measured:

1) Cognitive: Although the question of categorizing YUBAT question items for "Understanding" based on Bloom's cognitive taxonomy[3] was raised[4] during the construction of YUBAT, there is no evidence that such a categorization was made.[5]

2) Content: Several different orientations for guiding the development of question items by the development committee were tried.

[1]Material used in this appraisal was drawn from files helpfully provided by Dr. Davey.

[2]AERA, *Technical Recommendations*.

[3]Bloom, ed., *Taxonomy*, pp. 186-193.

[4]K. G. Davey, Memorandum to Test Development Committee (January 22, 1975), p. 1.

[5]Farquhar, *York Biology Test* (Informal Technical Report, 1975).

Item writers from the Biology faculty were asked to submit questions[1] reflecting what they felt was and should be covered in the Ministry of Education grade 13 Biology guideline, even though the guideline was seen to be too vague to be of help in writing items.[2] Item writers from the development committee were asked to consider categorizing question items into content "Areas" based on "grade 13 Units (1-7)" and on control "Processes."[3] However, there is no evidence that such categorizations or checklistings were made.[4] As well, there was some discussion in the development committee over the extent to which items would be factual (York faculty preference) or relate to more general intelligence factors (the teachers' preference).[5] There is no evidence that some or any of these orientations was used primarily. The only actual content division was by level of biological organization - cell, organism, and population. Test items were classified according to these levels into three sub-tests. The items were aimed at a 40% pass rate.

Selecting Suitable Methods and Techniques: For measuring achievement in grade 13 Biology, an objective test was constructed consisting of multiple-choice items. The time allotted for taking the test was two and a half hours.

Developing a Pool of Items: A pool of 800 items was developed by the Test development committee.

Having Items Reviewed by Qualified Persons: Of the pool of 800 items, 212 were retained for the actual test. The items were selected and reviewed by the seven members of the Test development committee. All members were from the fields of Biology or Biology Education. None was from the field of Measurement.

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[1] K. G. Davey, Memorandum to all York University Biology Academic Staff (January 2, 1975), p. 1.

[2] Ibid.

[3] Davey, Memorandum (January 22, 1975), p. 1.

[4] Farquhar, *York Biology Test* (Informal Technical Report, 1975).

[5] Interview with K. G. Davey and D. Farquhar, York University, December 5, 1977.

Administering Experimental Forms: (a) The Test was administered to a sample of twenty-one students from thirteen classes, and "a few improvements"[1] were made. No information was provided explaining the improvements or justifying the sample size, nor was the sampling method explained. Furthermore, there was no wide-scale pilot study undertaken to check the quality of the Test. (b) A restricted statistical analysis was done after the first administration of the Test in May 1975, with 1120 students from 74 schools. This analysis provided summary statistics for each school, score ranks and percentiles for each student, and a general item analysis. The item analysis consisted of an index of item difficulty and a discrimination index (FDI).[2] The FDI is an index of discrimination calculated as the difference in per cent between the upper and lower 27% of the total group divided by the percent of right answers for that item (if the per cent was less than or equal to 50) or by 100 minus the per cent (if the per cent was greater than 50).

Selecting Items for the Final Form: The information provided by the item difficulty index and the discrimination index calculated after the first wide-scale administration was not used in selecting items for a final form. The same test was used for three consecutive years, and thus may have lost some of its reliability.

Given this developmental and statistical history, the reliability of YUBAT remains in question. Further statistical analysis of individual items and of the test generally could be based on the results obtained from the several test administrations. Test administration procedures were not, however, controlled from school to school, and this lack of control would detract from the results of further statistical analysis of existing data. Furthermore, prior to the refinement of this test or similar ones, test aims would need to be specified against which reliability and validity estimates could be made. As is seen later in this report, test aims appear to

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[1] Farquhar, *York Biology Test* (Informal Summary Report, 1975), p. 2.

[2] Developed by YUBAT test committee faculty members.

have differed from time to time. Seventeen possible reasons for using the test have been identified by the investigators (see pp. 76-78).

REPRESENTATIVE COURSES OF STUDY

Guideline Unit Emphasis in Courses

The survey instrument contained the Guideline Unit Analysis Framework (Section III) in which teachers were asked to indicate the number of class periods per course allocated to each of the units and sub-units. This information was converted to a percentage of course time allocated and is presented in Appendix Table 4. A summary of these data is presented below in Table 6.

TABLE 6

Summary of Guideline Unit Analysis of Courses of Study[1, 2]

Content Areas		Percentage of Course Time Allocated Base A	Base B
Unit 1:	Characteristics of Living Things	5	6
Unit 2:	Cells	15	15
Unit 3:	Organisms		
	(A) Zoology	33	33
	(B) Botany	13	13
		46	46
Unit 4:	Classification	2	3
Unit 5:	Interdependence	7	9
Unit 6:	Heredity	12	13
Unit 7:	Evolution	4	5
	Totals:[3]	91	97

[1] Data base A indicates the average amount of time spent by all teacher respondents and includes those who did not treat the unit in their course.

[2] Data base B indicates the average amount of time spent on a particular unit by only those teacher respondents who treated the topic in their course.

[3] The figures do not total 100% because three non-guideline units were added to the Guideline Unit Analysis Framework in the survey instrument. Time allocated to these in responding teachers' courses accounts for the remaining percentages.

All of the units and sub-units are treated by some of the teachers (Appendix Table 4). However, our raw data show that many teachers did not cover at least one of the sub-units. As is seen later in this report, most teachers treat grade 13 Biology as an advanced course with prerequisites. Guideline units not treated by them in grade 13 are already treated in a prior course. As seen in Table 6, these course omissions by individual teachers did not significantly alter the average amount of time teachers spend on guideline units.

Almost half of the teachers' time (46%) is spent on the study of Organisms. Cells and Heredity receive almost equal time - each approximately 15%. Less than 10% of the course is, on average, given to each of Living Things, Classification, Interdependence, and Evolution.

Selected Content Emphasis in Courses

The results of the analysis of the teachers' courses of study for emphasis on Zoology *vs.* Botany, Genetics, Scientific Method, and Ecology are presented in Appendix Table 4. The results of the analysis of the 12 submitted course outlines for their emphases on Biochemistry and Homeostasis are presented in Appendix Table 5. This information is summarized below in Table 7.

TABLE 7

Summary of Six Selected Content[1] Emphases in Courses of Study

Content Emphases	Course Coverage %
Biochemistry	28
Ratio of Zoology to Botany	2.54:1
Genetics	12
Scientific Method	3
Ecology	7
Homeostasis	1

[1]The figures for Biochemistry and Homeostasis are a rough approximation based on the analysis of submitted course outlines (see Appendix Table 5). The data for the remaining four areas were collected in the survey instrument and the figures accurately summarize responses.

Biochemistry is heavily stressed in grade 13 Biology - about one-quarter to one-third of the course. It also appears from Appendix Table 5 that there is considerable variation from school to school, with one course outline indicating no emphasis on Biochemistry and one indicating an emphasis as high as two-thirds. It is interesting to note that the program with no Biochemistry contained units on animal behaviour and embryology, neither of which was found in any of the other outlines. In addition, this outline appeared to have a more heavy emphasis than did other programs on Ecology, Genetics, and Evolution.

Genetics receives a fairly extensive treatment (12%). Ecology, Homeostasis, and Scientific Method have less than 10% course time given to each, with both Scientific Method and Homeostasis receiving very little attention. According to the submitted course outlines (Appendix Table 5), nine of the twelve do not treat Homeostasis at all. Only one course appeared to treat Homeostasis in depth.

Cognitive Level Achieved in Course Instruction

For each unit and sub-unit in the Guideline Unit Analysis Framework, surveyed teachers were asked to specify the cognitive level attained with their last grade 13 Biology class. The results are presented in column 2 of the survey instrument, which shows the frequency and percentage of responses on items 40.1-40.47, beginning on page 82 in Appendix A. This information is summarized below in Table 8.

There are no striking differences among guideline units in the cognitive levels teachers think they achieve during instruction. Units 1 and 7 show the lowest level of achievement, with approximately 40% of the teachers achieving higher cognitive levels. Approximately 60% of the teachers reportedly achieve higher cognitive levels in Unit 2 and Unit 3(A).

Much of the variation in cognitive level achievement for units can be accounted for by the amount of time spent on each unit. Teachers report that a higher cognitive level has been attained by their students in units on which they have spent more time. For instance, teachers spent 36% of their time on Zoology, and 68% of these teachers expect their students to achieve higher cognitive levels in Zoology. Correspondingly, lower cognitive levels are expected by more teachers in units where they spend little time. For example, 61% of teachers

expect their students to have attained lower cognitive levels in Evolution, where only 4% of teacher time was spent. A possible inconsistency in this trend appears in Unit 4, with a lower vs. higher cognitive level ratio of about 1:1, even though teachers spent only 27% of their course time on this unit.

Overall, teachers claim to spend close to 60% of their time achieving higher cognitive levels, a figure which is strikingly at odds with the cognitive level balance in YUBAT. Teachers report that close to 20% of course time is spent on synthesis and another 7% on evaluation.

Course Characteristics

Data on this section are presented in Appendix A. Course characteristics are presented under the headings of goals, course development, prerequisites, resources, and evaluation. Survey instrument item numbers for each of these headings are listed in Table 2 and appear below in parenthesis.

Goals: Teachers believe their students should develop an attitude of scientific inquiry (12.1) and an understanding of scientific methodology (12.2). Half or more of the teachers noted each of the five listed inquiry skills as of either "considerable" or "a great deal" of importance (12.3.1 - 12.3.5). Skills aiding inquiry are also highly rated by teachers. Sixty-eight per cent of the teachers valued the student's capability in using a variety of laboratory equipment "considerably" or "a great deal" (12.8). In the same categories 68% also favoured the student's becoming able to utilize a variety of laboratory procedures, texts, and techniques (12.9). Familiarity with use of the microscope was an aim rated very highly by 82% of the respondents.

The reading by students of specialized research and layman journals in biology was not highly valued. The majority of responses fell in the "not at all" to "somewhat" categories: layman journals - 65% (12.12); specialized research journals - 91% (12.13); and research papers - 83% (12.14). Opinion on the point that students "should be able to write a discursive account of a problem in an area of biology" is modally represented under "considerably," at 34% (12.17). This form of expressing biological knowledge is considerably different from the

TABLE 8

Summary of Cognitive Level[1] Emphases in Course Instruction

Content Area	Cognitive Level[2] (% Respondents) Lower: Knowledge	Understanding	Higher: Application	Synthesis	Evaluation	% of Course Time Spent[3]	Cognitive Level[4] Course Emphasis (% Course Time) Lower: Knowledge	Understanding	Higher: Application	Synthesis	Evaluation
Unit 1: Characteristics of Living Things	30	30	31	9	1	6	1.8	1.8	1.9	0.5	1.0
Unit 2: Cells	13	25	33	27	2	17	2.2	4.3	5.6	4.6	0.3
Unit 3: Organisms											
(A) Zoology	7	25	34	25	9	36	2.5	9.0	12.2	9.0	3.2
(B) Botany	20	33	34	12		14	2.6	4.3	4.4	1.6	0.1
Unit 4: Classification	32	20	36	11	2	2	0.6	0.4	0.7	0.2	.04
Unit 5: Interdependence	17	29	28	15	12	8	1.4	2.3	2.2	1.2	1.0
Unit 6: Heredity	12	31	35	16	6	13	1.6	4.0	4.6	2.1	0.8
Unit 7: Evolution	24	37	21	18	1	4	1.0	1.5	0.8	0.7	.04
						Sub-Total:	13.7	27.6	32.4	19.9	6.5
						Total:	41.3		58.8		

[1]The average percentage of teachers for each cognitive level Unit entry is a simple average of the sub-unit percentages. (See Appendix A.)

[2]Lower and higher cognitive level are specified by definition B, Table 5.

[3]Since Table 6 demonstrated that the two methods of calculating percent time given to each unit did not yield significantly different results, only one method of calculation is used. The % of Course Time Spent entries are calculated by multiplying the Base A data in Table 6 by a factor of 1.1 to bring the total to 100%.

[4]The course emphasis on each cognitive level is found by multiplying the percent respondents for each cognitive level by the % of Course Time Spent.

multiple-choice form dictated in YUBAT. The development of higher-order cognitive skills is valued positively as well. For instance, "somewhat" and "considerably" account for 61% of the responses relating to "applications of the principles of biology" (12.4). Furthermore, 57% of the responses fall in these categories in relation to the "historical development of the ideas and concepts of biology" (12.5).

Course Development: The factors which were of "considerable" influence in teacher course development are the subject matter backgrounds of students (9.2), Circular HS1 (9.5), and the grade 13 Biology curriculum guideline (9.6). Those with "somewhat" of an influence were interests of students (9.1), courses taken currently by students (9.3), information on future courses, programs, and career choices of students (9.4), the teachers' special interests or training (9.8), and the content and approach of principal texts (9.9). Considerations which had very little influence on teachers' course development were the course outline assigned to them (9.7), and YUBAT (9.10). Thus, teachers claim their courses are built mainly around their students and what the Ministry authorizes. Other concerns taken into account are their own interests and available resources. They reportedly resist external influences. There is considerable variation in individual teacher responses, and each factor was noted by some teachers as having no influence and, with the exception of YUBAT, by other teachers as having a great deal of influence.

Prerequisites: Eighty per cent of the teachers claim that the reason they occasionally pay scant attention to some grade 13 guideline units is that the material is covered in other courses (41). Therefore, it is not surprising to find that for 99% of the teachers, prerequisites or corequisites are strongly recommended for students taking grade 13 Biology (10). Chemistry was the most frequently mentioned co- or prerequisite (81%), followed by Biology (60%) and General Science (27%). Very few teachers, less than 6%, required any one of Physics, Mathematics, or Biochemistry.

Resources: Textbooks are the main course resource (13.1) and are used "considerably" or "a great deal" by 76% of the respondents. Of the three main texts analysed by the study (see section on representative textbooks) nine teachers use Penny and Waern, three teachers use Moore *et al.* (BSCS Yellow), and 35 teachers use Galbraith and Wilson.

Of the other texts used, Kimball was the choice of 34 teachers and BSCS Blue was identified by seven teachers (14).

Textbooks are supplemented to a considerable or greater extent by other textual material by 57% of the teachers (13.2); by mimeographed notes by 38% of the teachers (13.3); by reference books, dictionaries, encyclopedias, and journals by 37% of the teachers (13.4); and by audio-visual aids by 42% of the teachers (13.7). Laboratory and/or computer equipment is similarly noted by 32% of the teachers (13.6). The least used resource was "individualized learning packages," with "not at all" as the modal choice by 47% (13.5) of the teachers.

Evaluation: The majority of teachers do not favour individualized student progress, with 30% choosing "not at all" and 33% choosing "a little" (15). Most of the remainder, 32%, are in the "somewhat" category. This may increase the possibility for students to do well on YUBAT, as the Test is a one-chance, one-mark situation. Students progressing at their own rates would likely have more than one chance to be assessed prior to a mark being assigned. These students might find the YUBAT testing situation somewhat intimidating.

Excluding from the count six teachers in whose schools there is no final exam as a school policy, 54% of teachers say that it is "possible for students to be exempt from writing the final examination in grade 13 Biology on the basis of term work," whereas 37% say this is not possible (16). The main basis for this exemption is "written tests," at 86%. Oral and written tests are used by 11% of the teachers and 3% use the students' research program performance (17). From this evidence it would appear that teachers emphasize formal testing and that students should, in general, be reasonably well prepared for the writing of YUBAT.

When teachers were asked to break down the components of the students' final mark (19), final examinations were the largest component (19.1). Still, only 29% of the teachers used the exam for over 60% of the final mark. Most teachers assigned over 20% of the final mark to each of final examinations (19.1), mid-term examinations (19.2), and other written tests (19.3). About 20% of the teachers used student papers to assign 20% or more of the final mark. Once these factors are accounted for, however, there is very little other influence on the students' final grade, including oral tests (19.4), student projects

(19.6), group work (19.7), problems and exercises (19.9), laboratory and/or class participation (19.10), effort (19.11), attendance (19.12), and other (19.13).

THE CONTENT OF REPRESENTATIVE BIOLOGY TEXTBOOKS

Guideline Unit Emphasis of Textbooks

The content of each of the three textbooks analysed with the Guideline Unit Analysis Framework is presented in Appendix Table 6. As in other applications of the Framework, categories were added to permit a complete content classification. Results are summarized below in Table 9.

TABLE 9

Summary of Guideline Unit Emphasis in Three Textbooks: Percentage Page Count

Content Areas	Penny & Waern %	Galbraith & Wilson %	Moore *et al.* %
Unit 1: Characteristics of Living Things	8	11	18
Unit 2: Cells	20	11	14
Unit 3: Organisms			
(A) Zoology	22	27	21
(B) Botany	16	21	9
	38	48	30
Unit 4: Classification	9	3	1
Unit 5: Interdependence	7	11	12
Unit 6: Heredity	8	7	11
Unit 7: Evolution	8	7	14

All three books stress the study of Organisms; a little less than a third of the Moore book and about a half of the Galbraith and Wilson text focus on this unit.

Cells are the second most emphasized unit in Penny and Waern, and for Moore it is the Characteristics of Living Things, while Galbraith and Wilson give equal time to Characteristics of Living Things, Cells, and Interdependence.

With the exception of Classification, which it barely emphasizes, Moore more nearly balances its treatment of the guideline units than do the other two texts. Penny and Waern and Galbraith and Wilson are fairly similar in their text treatments of guideline units, while Moore tends to vary, especially in its treatment of Organisms, Classification, the Characteristics of Living Things, and Evolution.

Selected Content Emphases of Textbooks

The calculation of the six selected content emphases in each of the three textbooks is presented in Appendix B. The results are summarized below in Table 10.

TABLE 10

Summary of Selected Content Emphases in Three Textbooks: Percentage Page Count

Content Emphasis	Penny & Waern (%)	Galbraith & Wilson (%)	Moore *et al.* (%)
Biochemistry	29	22	19
Ratio of Zoology to Botany	1:1	1:1	2:1
Genetics	8	7	11
Scientific Method	low	moderate	high
Ecology	7	11	12
Homeostasis	2	2	1

Penny and Waern is the most Biochemistry oriented text and Moore the least. Moore has about twice as much emphasis on Zoology as on Botany, while the other two books only slightly emphasize Zoology over Botany. The textbooks are more or less similar in their treatment of Genetics and of Homeostasis. Homeostasis has a low overall emphasis in all three books. Moore's is the only one of the books to have a high emphasis on Scientific Method. This book has the most emphasis of the three on Ecology.

YUBAT COMPARED WITH COURSES OF STUDY AND TEXTBOOKS

The first research task was to examine and assess YUBAT in the light of the provincial grade 13 Biology curriculum guideline, representative courses of study, and representative textbooks. Our discussion is organized according to the relative emphasis in all of these on guideline units, selected content emphasis, and cognitive level of achievement.

Guideline Unit Emphasis

The emphasis on guideline units in YUBAT compared with the teachers' courses of study and with the three textbooks is summarized in Table 11.

TABLE 11

Summary Comparison of Guideline Unit Emphasis in YUBAT, Courses of Study, and Textbooks

Content Area	YUBAT[1]	Courses of Study[2]	Penny and Waem[3]	Galbraith & Wilson[4]	Moore et al.[5]
	%	%	%	%	%
Unit 1: Characteristics of Living Things	2	5	8	11	18
Unit 2: Cells	24	15	20	11	14
Unit 3: Organisms					
(A) Zoology	31	33	22	27	21
(B) Botany	10	13	16	21	9
Unit 4: Classification	6	2	9	3	1
Unit 5: Interdependence	8	7	7	11	12
Unit 6: Heredity	13	12	8	7	11
Unit 7: Evolution	6	4	8	7	14
Totals:	100	91	100	100	100

[1] See Appendix Table 1.

[2] See Appendix Table 4.

[3] See Appendix Table 6.

[4] See Appendix Table 6.

[5] See Appendix Table 6.

YUBAT and Courses of Study: It appears that with the exception of the study of Cells, YUBAT items are concentrated in the same content areas and in closely the same proportions as is grade 13 course time. Teachers do not emphasize the study of Cells quite as much as does YUBAT, and there is also some indication that Classification is in a similar position. Nevertheless, the striking feature of the comparison is that YUBAT closely fits teacher program emphasis on Ministry guideline units.

YUBAT and Textbooks: There is variation from book to book, and partly as a result of this the comparison of textbooks with YUBAT is not as clear as it was with teacher programs, where variation was obscured by averaging all program data. Nevertheless the overall impression is that two of the textbooks are closely related to the YUBAT emphasis on guideline units. The textbooks have considerably more emphasis on the Characteristics of Living Things. Two of them have less emphasis than YUBAT on Cells and Classification and they all have somewhat less emphasis on Organisms. Penny and Waern is the most similar in emphasis to YUBAT and Moore *et al.* the least.

YUBAT, Courses of Study, and Textbooks: On balance there is a great deal of similarity among YUBAT, the courses of study, and two of the textbooks in their emphasis on Ministry of Education guideline units. With the possible exception of YUBAT's high emphasis on Cells there are no striking differences between YUBAT, the courses, and two of the textbooks. It should be noted that the grade 13 Biology guideline units are not given a balanced treatment in YUBAT, courses of study, and textbooks. The guideline does not specify what relative emphasis the units should achieve, and it is therefore impossible to judge whether the imbalance is a matter of concern from the point of view of policy.

We noted one other overall discrepancy with the guideline during our study. In order to classify items, course content, and pages properly, it was necessary to add categories. Table 12 summarizes the percentage of content covered by our added categories.

From Table 12 it can be seen that from a third to a half of our classifications were made by categories added to the guideline. YUBAT, the courses of study, and two of the textbooks have about 30% more subunit topics than are specified in the Biology 13 guideline. Moore *et al.*

TABLE 12

Content Additions to Guideline Units for Complete Classification of Items

Material Analysed	%
YUBAT	32
Courses of Study	31
Textbooks:	
Penny and Waern	26
Galbraith and Wilson	32
Moore *et al.*	50

is, again, the one textbook which differs significantly in that 50% of its content is not listed in the guideline. Since grade 13 Biology almost always has prerequisites, these added categories are perhaps not surprising; students may have already covered the added categories in earlier grades.

Selected Content Emphases

The relative emphasis on the six selected content areas in YUBAT compared with the teachers' courses of study and with the three textbooks is summarized in Table 13.

TABLE 13

Summary Comparison of Selected Content Emphases in YUBAT, Courses of Study, and Textbooks

Content Emphasis	YUBAT[1] %	Courses of Study[2] %	Penny and Waern[3] %	Galbraith & Wilson[4] %	Moore *et al*[5] %
Biochemistry	36	28	29	22	19
Ratio of Zoology to Botany	2.8:1	2.5:1	1:1	1.3:1	2.3:1
Genetics	14	12	8	7	11
Scientific Method	8	3	low	mod.	high
Ecology	4	7	7	11	12
Homeostasis	9	1	2	2	1

[1]See Appendix Table 3.

[2]See Appendix Table 4.

[3]See Table 10.

[4]See Table 10.

[5]See Table 10.

YUBAT and Courses of Study: In general YUBAT shows a similar pattern of emphasis to the teachers' courses of study. Both are high on Biochemistry, both exhibit about the same emphases on Genetics and about the same ratio of Zoology to Botany, and both have a low emphasis on Scientific Method, Ecology, and Homeostasis. However, even though the balance is similar there are certain notable differences. YUBAT has more emphasis on Biochemistry, Scientific Method, and Homeostasis and less emphasis on Ecology than do the teachers' courses of study. It would appear that the emphasis on Biochemistry in YUBAT is excessive and that the extra YUBAT emphasis on Scientific Method and Homeostasis is desirable. The teachers' courses of study seem excessively low in these latter two areas. However, it is entirely possible that the data collection procedure was not sensitive to those two areas and that courses actually have more emphasis on them than is shown. It should also be noted that teachers report that these areas are covered in prerequisite courses.

YUBAT and Textbooks: Again, YUBAT shows a similar pattern of emphasis to the textbooks. Biochemistry, Genetics, and Homeostasis and Zoology compared to Botany are emphasized more heavily in YUBAT than in any of the three textbooks, while Ecology shows less emphasis in YUBAT. It is difficult to directly compare YUBAT with the textbooks for Scientific Method. However, it would appear that Moore *et al.* has a significantly greater emphasis than YUBAT. Overall Moore *et al.* is, again, the textbook least similar to YUBAT on the six content emphases, while Penny and Waern appears to be most similar.

YUBAT, Courses of Study, and Textbooks: On balance there is a great deal of similarity in emphasis among YUBAT, the courses of study, and two of the textbooks. There are, of course, differences. YUBAT stresses Biochemistry, Zoology over Botany, and Homeostasis more than do the courses and textbooks, but YUBAT has less emphasis on Ecology. With the exception of the Moore *et al.* textbook, Scientific Method is not heavily emphasized.

Cognitive Level Emphasis

The cognitive level of YUBAT items compared with the cognitive level achieved in courses of study is summarized in Table 14.

TABLE 14

Summary Comparison of Cognitive Levels Emphasis in YUBAT and Courses of Study

Cognitive Level	YUBAT* %		Courses of Study† %	
Evaluation	1		7	
Synthesis	5	18	20	59
Application	12		32	
Understanding	23	82	28	42
Knowledge	59		14	

*See Table 5.

†See Table 8.

YUBAT and Courses of Study: The cognitive level of YUBAT is strikingly lower than the level teachers reportedly achieve in their teaching. Eighty-two percent of YUBAT items test lower cognitive processes, while teachers report that only 42% of their teaching is aimed at this level. According to the teachers their teaching is reasonably well balanced cognitively, with most emphasis on the process of application.

These striking differences should, however, be treated cautiously. Given the teachers' reported satisfaction with the various components of the Test, it would appear that teachers did not detect the sharp discrepancy between YUBAT and their own teaching. It may, in fact, be the case that teachers interpreted the cognitive levels somewhat differently than was intended by the researchers. If this is the case, it is possible that the teachers' programs would not show as much higher-order emphasis as reported. Without further validation research on the use of cognitive level terms this question cannot be settled.

While the guideline does not specify cognitive levels precisely as defined in this study, it is our strong impression from reading the guideline that the policy intention aims at cognitive levels higher than those tested in YUBAT.

TEACHER USER OPINION

Data for this section are presented in the survey instrument, Frequency and Percentage of Responses, located in Appendix A. Teacher

user opinion is summarized in the five sections below. Survey instrument item numbers for each of these sections are listed in Table 2 and appear below in parenthesis.

Teacher Perceptions of the Influence of YUBAT on Their Grade 13 Biology Programs

A somewhat surprising 23% of the teachers indicated that YUBAT had some influence on their teaching (9.10). One teacher rated the influence as considerable. Twelve percent of these teachers rated YUBAT as only having a little influence and 77% indicated it had no influence at all. The Ministry of Education Biology Curriculum Guideline for 1969 was rated as having the highest influence (9.6) followed by Circular HS1 (9.5). In a related question where teachers were asked to indicate the importance of various reasons for using YUBAT, 40% of the teachers indicated that YUBAT could help them plan their course (35.8), and 61% of the teachers felt that it could serve to identify strengths and weaknesses in their grade 13 Biology course (35.10). Interestingly, while only 5% thought that it would be of considerable or greater help in the planning of their course, 19% felt that it would be a considerable or greater help in identifying weaknesses in their course.

Even though teachers reported YUBAT as having a fairly high level of influence on the teaching of their course, they reported little in the way of special preparation of students for the Test. Only 12% of the teachers indicated that they occasionally made an effort to prepare students specifically for writing YUBAT (23), and only 8% of the teachers indicated they had conducted a special class to prepare students for YUBAT (24). A smaller grouping, 7%, reported coaching specific students for YUBAT (25). Furthermore, it would appear that neither principals, department heads, nor students request changes in teaching method (36.1, 37.1), content (36.2, 37.2), or method of student assessment (36.3, 37.3). Only 4% of the teachers indicated that students had requested a change in course content (37.2) and only 3% indicated that the principal or department head had requested any change in content or method of assessment (36.2, 36.3). However, 18% of the teachers indicated that they had used YUBAT items in their own grade 13 Biology testing program (38).

The picture changes somewhat when teachers were asked if they

would change their program if they found that a standardized achievement test used for admission at one or more universities differed in emphasis from their own grade 13 Biology course (21). While 54% of the teachers indicated that the standardized achievement test would have no influence on their teaching method (21.1) and 64% indicated no notable influence on their method of student assessment (21.3), only 19% indicated that they would *not* change the content of their course (21.1).

In summary it would appear that teachers are less than anxious to modify their programs on the basis of achievement tests. They are most likely to be influenced in content areas, less so in teaching method, and still less in their method of assessment. The majority of teachers, 61%, however, feel that students gain educational benefit from taking standardized tests (22).

Teacher Perceptions of the Influence of YUBAT on Students

According to teacher responses, students indicated a fair amount of enthusiasm for taking YUBAT (32). Only 12% of the teachers indicated that students showed no enthusiasm for the Test and 19% reported considerable or higher enthusiasm on the part of their students. On the other hand, 20% of the teachers felt that when students received their scores, they were negatively influenced (33). This is counterbalanced to an extent by the fact that 33% of the teachers felt their students were positively influenced, while the remaining 47% felt there was no influence, upon receiving their test scores. Only 8% of the teachers thought that their students' interests in pursuing further studies in Biology were negatively influenced by writing the Test, and 14% felt the students were positively influenced (34). It is worth noting that the teachers are almost certainly responding having in mind the small and select group of students who actually took the Test.

The majority of teachers, 61%, felt that students gain educational benefit from being required to take standardized tests. A total of 52% of teachers felt that in the awarding of final marks for grade 13 Biology there should be a change in current practices, either toward a voluntary test such as YUBAT, 32%, or toward required use of an external test such as YUBAT, 20% (30). Either there was some inconsistency on the part of some of the teachers on these two questions, or, more likely, teachers probably feel there is some value in standardized

testing apart from the question of educational benefits for students.

Teacher Satisfaction with YUBAT

Teacher satisfaction with YUBAT is divided into four parts—Test characteristics, the Test as a measure of student achievement, the Test as a measure of teacher effectiveness, and the Test as a measure of the school's program in Biology.

Overall, teachers appear to be fairly satisfied with YUBAT (26). Half of the teachers rated their satisfaction with the Test as fair or poor and half as good or better (26). The highest level of satisfaction was with the multiple-choice format (27). About 20% of the teachers, those rating their satisfaction either fair or poor, preferred some other item format. Teachers were least satisfied with the time of year at which the Test was administered (27.4). Teacher notes attached to the response forms suggest that the Test came too late in the year for teachers on a semester system who taught a fall program, and too early in the year for teachers whose course was running in the spring. Over 50% of the teachers thought the choice of items was either fair or poor (27.2). But this implied criticism of the Test did not show up when teachers were asked to rate their satisfaction with the level of difficulty (27.5), test item detail (27.6), and the level and amount of concepts, theories, and principles tested (27.7). For the difficulty, detail, and conceptual content, teachers' responses were reasonably evenly distributed across the five response categories with the modal response in each case being "good".

Teachers appeared to be reasonably satisfied with YUBAT's capacity to measure student achievement in biological content (27.8.1), research skills in biology (27.8.2), understanding of biology (27.8.3), the application of biological principles (27.8.4), and the ability to investigate and generalize about a wide range of biological problems (27.8.7). Teachers were somewhat less satisfied with the Test's capability to measure a student's achievement in synthesizing knowledge for an understanding of the whole of biology (27.8.5). They were dissatisfied as well with the potential of YUBAT to evaluate principles, applications, limitations, and research procedures of biological knowledge (27.8.6). It is difficult to understand how teachers could be satisfied with the Test's potential to indicate student achievement in research skills in biology (27.8.2) or to investigate and generalize about a wide range of biological problems

(27.8.7) since, as was shown in the analysis of YUBAT, these items are nominally tested. The implication is that these areas are not a significant part of teachers' programs although, as shown earlier, teachers rate these as significant goals for their programs.

Teachers were least satisfied with the Test's ability to measure teacher effectiveness (27.9) and they also exhibited low satisfaction with the Test's ability to measure a school's program in Biology (27.10). It should be borne in mind, however, that the data on teacher satisfaction would suggest that while teachers are not overly enthusiastic about YUBAT, they do indicate a reasonably positive stance towards standardized testing in Biology. This might suggest that if the Test were carefully prepared and administered to reflect teacher programs and teacher schedules more accurately, teachers might be more willing to consider standardized tests to be of value in indicating teacher effectiveness or to be useful as a measure of school program. The investigators were somewhat surprised that only 45% of the teachers rated themselves as being poorly satisfied with the Test as a measure of teacher effectiveness and 40% for the Test as a measure of school program. It is possible that if the Test were improved there would be no serious objection from teachers to the use of the Test for these two purposes. It should be noted, however, that only 16% of the teachers thought that YUBAT should be used with all students (28). Most thought the Test should be used on a voluntary basis, and 8% of the teachers thought that the Test should not be used at all. It is worth noting the teachers were consistent on two correlated items on this point (28 and 30).

Teacher Views on the Application of YUBAT

Most teachers do not think that YUBAT should be used for all grade 13 students (28 and 29). This view is not restricted to YUBAT but applies to testing in general (30). About half the teachers felt that there should be no change in current testing practices and only 20% thought that there should be a required use of an external test such as YUBAT. About a third of the teachers felt that it would be useful to have an external test such as YUBAT for use on a voluntary basis (30). Approximately 80% of the teachers felt that YUBAT should be used only voluntarily (28, 29).

Teacher Views on Standardized Testing in General

This section summarizes data which have been discussed in various of the areas described above. About 60% of the teachers feel that students benefit from the taking of standardized tests (22). At the same time 47% of the teachers feel there should be no change in current testing practices (30). Presumably the discrepancy is accounted for by the fact that teachers may use some standardized tests or sections of tests in their own testing programs. Only 20% of the teachers feel there should be required use of an external test to provide all or part of a grade 13 Biology mark. When teachers were asked what they believed would be the influence of a standardized achievement test on their own programs, the area they felt to be most likely affected was program content (21.2). Over half of the teachers felt that it would not affect their teaching method (21.2) nor their method of student assessment (21.3). Still, it is worth noting that the other half of the teaching population who would be affected represents a rather significant figure. When teachers were asked if they had actually ever modified their program as a result of standardized tests, far fewer teachers gave positive responses (20.1, 20.2, 20.3). Content still remained the item most affected (20.1). Presumably, many of these teachers had not taught under a system of external examinations.

When teachers were asked who they felt should prepare an external exam if one were to be developed (31), by far the highest percentage of teachers, about two-thirds, preferred a joint development team of teachers, Ministry of Education personnel, and faculty from university departments of Biology. However, about one-fifth of the teachers felt that a joint teacher-university committee would be the best way to develop the test. This, of course, was the procedure followed with YUBAT, although it is our impression that the York University staff had the major influence over YUBAT's development.

ACHIEVEMENT OF YUBAT AIMS

York University Faculty Opinion

York University Aims: The aims of YUBAT as seen by York University personnel in their files and in interviews are presented in Appendix Table 7. This information is summarized in the form of the following seven aims:

1. influence grade 13 Biology curriculum to provide greater uniformity among schools;
2. identify possible students for York;
3. allow exemptions from parts of York Biology courses for exceptional students;
4. improve the general visibility of York science in schools;
5. help teachers assess their own effectiveness in Biology teaching;
6. permit recognition of outstanding achievement by students;
7. provide some liaison between York and the high schools.

Interview Results: The results of an interview with Dr. Davey to determine, in his view, how well the seven aims were being achieved are presented below organized according to each aim.

1. Influence grade 13 Biology curriculum to provide greater uniformity among schools.

Dr. Davey said that he does not really know how well this aim has been achieved because York has no record of which items are done well by students from what schools. Therefore, he cannot identify any commonality among particular school Biology curricula. He went on to say he hoped that teachers were not teaching toward YUBAT. He said he wanted a common core in grade 13 Biology but it did not matter to him what composed the core. He admitted to some chagrin about this core because at a meeting of Ontario Chairmen of University Biology Departments his colleagues saw no necessary relationship between grade 13 Biology and university Biology.

2. Identify possible students for York.

Dr. Davey said that although this may have been an aim early in the YUBAT program it was not an aim now. In fact, he has not made any attempt to track YUBAT prize-winners who may be at York.

3. Allow exemptions from parts of York courses for exceptional students.

Dr. Davey said that no advanced standing had been granted so far. This has been due partly to York's inability to identify a section of their Biology program that matched the YUBAT content. However, this kind of exemption is still a possibility.

4. Improve the general visibility of York science in schools.

Dr. Davey noted that York University still has an image problem.

5. Help teachers assess their own effectiveness in Biology teaching.

Dr. Davey said that he does not know how well this is being achieved. He does not meet that large a sample of teacher-users. He said, furthermore, that there has been modest pressure from teacher-users, which York has resisted, for York to provide comparison information. He said that he refuses to collect "school X *vs.* school Y" data. He noted that such comparison has little value because teachers use different bases for selecting students to write YUBAT.

6. Permit recognition of outstanding achievement by students.

According to Dr. Davey this aim has been achieved.

7. Provide some liaison between York and the high schools.

Dr. Davey said that although this is low on his list of priorities, some success has occurred in this area.

In summary, no attempt has been made to determine the achievement of some of the aims and others appear not to have been met. The main exception is the aim of permitting recognition of outstanding achievement by grade 13 Biology students.

Teacher Members of YUBAT Development Committee

The interviews with the original teacher members of the YUBAT development committee are summarized below according to the interview questions. A reader will notice that there was considerable diversity of opinion among those interviewed. The diversity of responses was seen as consistent with the wide variety of reasons for using the Test evident in the survey instrument responses (items 35.1-35.17). Detailed reports of each interview are available on request.

(1) What were the reasons you had for getting involved in initiating the Test?

Three of the teachers wanted a vehicle to help select top Biology students. Their reasons varied: teachers A, B, and D wanted to provide more challenge for these students; teacher A also wanted to help students develop an awareness of what would be expected of them in university-level Biology. Two of the teachers (A and C) said they became involved in initiating the Test because they thought the Test would help a return to a province-wide uniform Biology curriculum. Teacher A said that the main beneficiary of uniform curriculum would be teachers, while teacher C thought it would be the universities.

(2) What goals did you anticipate would be achieved by the Test?

Teacher members of the YUBAT development committee expected that two related goals would be achieved. Teachers A and B anticipated that the Test would shape thinking about what ought to be taught in senior Biology, and teacher C anticipated that the Test would be seen as a prototype for a province-wide external exam in grade 13 Biology. Teacher D also saw that the Test could influence the content of secondary school Biology curriculum, but, in contrast, he said this outcome would be undesirable.

(3) Would you supply some details about how you used the Test?

The teachers answered this question in terms of the basis on which their students were selected to write the Test. While teachers A and C said about one-third of their grade 13 Biology students wrote YUBAT voluntarily, teacher B said that he administered the Test to less than 10% of his students. Teacher D administered YUBAT to the few students who volunteered.

(4) For which cognitive skills[1] were you testing?

Opinion among the teachers differed on the level of cognitive skills for which YUBAT was testing. While teacher A said that higher-level cognitive skills were being emphasized, teachers B and C thought the Test emphasized lower-order cognitive skills. Teacher D said YUBAT was intended to test for a balance of higher and lower cognitive skills.

(5) What is your opinion about the success and/or failure of the Test?

The Test was seen by teachers A, B, and D as successful in helping them select top Biology students. Also, teacher A saw YUBAT as providing a fair way for competing for Biology entrance places at university. However, teacher B had reservations about the validity and reliability of the Test, and in retrospect Teacher C did not like the multiple-choice format nor the time of school year that the Test is administered. Teacher C also thought YUBAT was a little too long.

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[1] "Higher" and "lower" cognitive levels as in definition B, Table 5.

(6) Has your use of the Test any implications for your own program?

Where implications were seen, they were significant, as they bring into question the reliability of YUBAT. Teacher B said students were alerted to what areas were being tested, and teacher C said that he used some of the YUBAT question items in his own tests. Teacher D said there were no implications for his program, and teacher A made no response to the question.

(7) What are your general views about testing?

Teacher A favoured external achievement testing in other subjects as well as in Biology, and teacher B favoured external achievement tests on a province-wide basis, but not for 100% of a student's final mark. Teacher C did not favour achievement tests using a multiple-choice format. Teacher D did not reply to the question.

(8) Have you any other comments to make?

The other comments by the teachers took the form of recommendations. Teachers B and C recommended creating an item bank, containing questions similar to the YUBAT items, from which Biology teachers could draw in developing their own classroom or school tests. However, teacher D did not favour such a question item bank and recommended, instead, a yearly revision of the Test with the revision committee being changed annually.

Teacher Reasons for Using YUBAT

Data on this section are presented in the survey instrument in Appendix A. Item numbers appear in parenthesis below.

Teachers were given seventeen possible reasons for using YUBAT and asked to rate the degree of importance they would attach to each. These seventeen reasons subdivided into reasons related to the student (35.1, .2, .3, .4, .6, .11, .12, .13, .14, .16); to the teacher (35.7); and to program planning (35.3, .8, .10, .15).

All of the reasons were picked by some of the teachers and, conversely, every reason had a significant number of teachers rating it as not important at all. None of the reasons was chosen by an overwhelming number of teachers. The most significant reasons had to do with students. The most highly rated item was that the Test provides a high level of challenge to students (35.13). Generally speaking, the results would indicate somewhat lukewarm feelings towards various reasons for

using the Test. The modal response category throughout, with one exception (35.13), was "somewhat" or less. Still, with the exception of two items (35.2, 35.9) all reasons listed were rated by at least some teachers as being of a great deal of importance. Somewhat surprisingly, only 41% of the teachers thought that the Test was not at all important as an indicator of teacher competence. Fifty percent of the teachers indicated that one reason for using the Test was to pave the way for a return to province-wide Biology programs (35.15).

The three reasons whose modal response was other than "not at all" were all student reasons and concerned measuring the level of achievement for individual students (35.1), helping students gain a better understanding of their strengths and weaknesses (35.4), and having a valid indicator of student learning (35.6). Over half of the teachers thought that it was not at all important to use the Test for helping guide students into post-secondary programs (35.2), helping the teacher to plan her course (35.8), serving as a prototype for a return to province-wide exams (35.13), and gaining advanced standing in university (35.16). Many teachers saw no special reason for using the Test but saw no harm in its use (35.17).

This somewhat lukewarm response is corroborated by the fact that 47% of the teachers did not want a change in current testing practices and an additional 32% wanted a change only to the voluntary use of an external test such as YUBAT (30). Only 20% of the teachers thought there should be a return to the required use of external tests (30).

PRINCIPAL AND SUPERVISORY OFFICER OPINION

The principal and supervisory officer opinions are summarized below according to the two interview questions. Detailed accounts of each interview are available upon request.

(1) How valuable, or otherwise, is YUBAT?

Only two principals (B and C) had any knowledge of YUBAT. Both favoured external achievement testing for purposes of comparing student performance. Principals A and D did not support YUBAT or external achievement testing. Principals F and G had neither knowledge nor opinion about YUBAT. Principal E favoured using YUBAT if his Biology specialist department head did so.

Four supervisory officers knew of YUBAT. Two (A and F) were guardedly in favour of it for diagnostic purposes. C was against both YUBAT and external achievement testing. D favoured use on an individual teacher basis. The remaining two (B and E) had no opinions on YUBAT.

(2) What is the potential value of YUBAT?

Principal D did not favour any future use of external achievement testing. Principal A did not favour future use of YUBAT. The remaining five supported external achievement testing for reasons mainly to do with comparing student, teacher, and program performance. The use of external achievement testing as a diganostic tool was mentioned by two principals (E and F).

Supervisory officers A, B, and F viewed the continuing use of YUBAT and some form of general external achievement testing favourably; yet each of these attached a condition. A saw a need for the measurement of process objectives, B wanted an external achievement evaluation norm-referenced for his school board, and F did not want rigid test usage. Supervisory officers C, D, and E viewed YUBAT and widespread external achievement testing negatively. C worried that increased usage of YUBAT might be the result of an oversimplified view of measurement and accountability; D worried about the general effect of testing procedures on curriculum; and E was concerned lest any external agency dictate what would amount to a straitjacket for curriculum.

To sum up, more supervisory officers than principals were aware of YUBAT. The supervisory officers differed on the Test's value. The principals viewed the Test positively. The supervisory officers were wary of external achievement testing generally. The principals appeared to favour such testing. This contrast may be accounted for by the different primary concerns of the groups. The principals were basically concerned with knowing where their schools stood in relation to performance of students, teachers, and program. The supervisory officers seemed interested mainly in guarding the rights of their particular boards to meet their own needs.

Voluntary Sources

School Board Research: The attitudes to YUBAT in the school board research appeared markedly different. This may be accounted for by the

different concerns apparent in the research. Board A seemed more concerned for the consequences for students of using the Test. Board A schools were not teaching and would not teach in such a way that their students were well prepared for YUBAT. As a result their brighter students became discouraged when they did poorly on the Test. On the other hand, Board B schools, with two exceptions, appeared to have had as their major concern the evaluation of Biology curricula. For them, an external achievement test for students (as curriculum products) appears to have constituted such a curriculum evaluation device. Hence the evident lack of concern in Board B for the potential of YUBAT to influence program.

Biology Department Heads Meeting: Following are results from asking two questions at a meeting of Biology department heads.

(1) How valuable, or otherwise, is YUBAT now?

One head noted that as a measure of grade 13 Biology course content YUBAT is not very good, and that any student in his school who did well on the Test had also taken grade 11 Biology. He said YUBAT was so difficult that students who saw the Test as a picture of university-level Biology were discouraged about continuing in Biology at university. Another head added that students were deflated by the marks they received on the YUBAT. Furthermore, the Test came at an inappropriate time during the school year. YUBAT had several questions on Genetics, and this was generally taught after the Test was administered. The heads cited the Waterloo Chemistry Test as excellent in comparison to YUBAT as far as being a good measure of grade 13 course content.

(2) What is the potential value of YUBAT?

The heads said YUBAT could have more potential if other universities as well as York were to offer advanced placement for students performing well on YUBAT.

In summary, the general feeling among the group of Biology department heads was that YUBAT was of little current value. It was not a good measure of grade 13 content, and it tended to discourage students from undertaking further Biology studies. Future value of the Test was seen only in terms of advanced university placement for students performing well on the Test.

Summary

This study of the York University Biology Achievement Test is summarized in terms of the four contracted tasks which specified the scope of the research.

ASSESSMENT OF YUBAT

The Task

The first task was to examine and assess the Test in comparison with the Ontario Department of Education *Biology: Grade 13* (1969) curriculum guideline, with representative grade 13 Biology courses of study, and with representative grade 13 Biology textbooks.

Methodology

For purposes of comparison, the Biology guideline served as the assessment reference standard. The guideline specifies seven content units, three approaches to Biology, and to a certain extent the cognitive level of goals to be achieved. The seven units are Characteristics of Living Things, Cells, Organisms (Zoology and Botany), Classification, Interdependence, Heredity, and Evolution. The seven units formed the framework for comparative analysis of YUBAT, courses of study, and textbooks. No attempt was made to compare biological approaches, although six content emphases that tend to cut across the outline of units were selected for analysis and comparison of YUBAT, courses of study, and texts. The six emphases are Biochemistry, Zoology/Botany ratio, Genetics, Scientific Method, Ecology, and Homeostasis. To compare the cognitive level of YUBAT items with the cognitive level of student achievement aimed at by teachers, a five-component grid was constructed based on Bloom's *Taxonomy of Cognitive Objectives* (1956).

The components of the grid are Knowledge, Understanding, Application, Synthesis, and Evaluation.

Information about representative courses of study was collected in two ways: in twelve printed course outlines solicited from teachers, and in Section III, Course Content, of a survey instrument received from 67 teachers who had used YUBAT.

Three representative textbooks were selected in consultation with Biology Faculty of Education members at the University of Toronto from *Circular 14 Textbooks* (1977). The authors of the three texts were Penny and Waern, Galbraith and Wilson, and Moore *et al.*

With one exception, the seven content units, the six selected content emphases, and the five cognitive levels were used to classify each YUBAT item, the representative courses of study, and the representative textbooks. The exception was the cognitive levels of the textbooks. This was not undertaken owing to the unpredictable variation among teachers in their cognitive level treatment of content material. The outcomes of these classifications were compared in summary tables.

The reliability of YUBAT was estimated by appraising the developmental and post-test procedures used by York University. Details about these procedures were obtained from York University records and interviews with York University Biology faculty members. The appraisal was made according to the technical recommendations for achievement tests of the Committee on Test Standards, AERA (1955).

Findings

The findings of the content unit comparison were that except for the study of Cells and to some extent Classification, YUBAT items are concentrated in the same content areas and in closely the same proportions as is grade 13 course time. It is apparent that YUBAT closely fits representative course of study emphasis on Ministry guideline units. Two of the textbooks, Penny and Waern, and Galbraith and Wilson, are closely related to YUBAT emphasis on guideline units. The texts place considerably more emphasis on the Characteristics of Living Things. Two have less emphasis than YUBAT on Cells and Classification, and all have somewhat less emphasis on Organisms. Penny and Waern is the nearest in emphasis to YUBAT, and Moore *et al* the most distant. On

balance there is a great deal of similarity among YUBAT, the courses of study, and two of the textbooks in their emphasis on Ministry of Education guideline units.

The findings of the selected content emphases comparison are that YUBAT shows a pattern of emphasis similar to the courses of study and to the two texts identified as similar above. There are differences. YUBAT stresses Biochemistry, Zoology over Botany, and Homeostasis more than courses or textbooks, but YUBAT has less emphasis on Ecology. With the exception of the Moore *et al.* text, Scientific Method is not heavily emphasized.

The findings of the cognitive level comparison are that YUBAT emphasizes much lower levels than the levels teachers reportedly achieve in their teaching. Teachers report that 42% of their teaching is aimed at the knowledge and understanding levels, while 82% of YUBAT items test at this level. Though the guideline does not specify cognitive levels precisely as defined in this study, the impression portrayed in the guideline is that higher cognitive levels ought to be achieved than are tested in YUBAT.

The findings on the reliability of YUBAT are that Test aims need to be specified against which reliability and validity estimates can be made, thus establishing a basis for refinement of the Test.

TEACHER OPINION

The Task

The second task was to survey teacher opinion on the value of YUBAT, its influence on the curriculum, and its use in the schools.

Methodology

Information was collected by a survey instrument circulated to all teachers who, according to York University records, had used the Test. Sixty-seven copies were returned. The teacher opinion topics in the instrument were: teacher perception of the influence of YUBAT on their grade 13 Biology programs; teacher perception of the influence of YUBAT on students; teacher satisfaction with YUBAT; teacher views on the application of YUBAT; teacher views on standardized testing in general; and characteristics of teachers' program. Instrument question items were classified according to topic and sub-topic (see Table 2). The

data were analysed by computer, and simple frequency (f) and percentage of respondents (%) for each response category were tabulated.

Findings

Teacher opinion on the value of YUBAT is divided into four parts: Test characteristics, and the Test as a measure of student achievement, of teacher effectiveness, and of the school's program in Biology. Overall, teachers appear to be fairly satisfied with the Test characteristics, such as the multiple-choice format, level of difficulty, Test item detail, and level and amount of concepts, theories, and principles tested. There was less satisfaction with the time of year the Test was administered. Teachers appear to be reasonably satisfied with YUBAT's capacity to measure student achievement in biological content, research skills in biology, understanding of biology, application of biological principles, and ability to investigate and generalize about a wide range of biological problems. Teachers were less satisfied with YUBAT's capacity to measure the ability to synthesize knowledge for an understanding of the whole of biology. They were less satisfied as well with the potential of YUBAT to evaluate principles, applications, limitations, and research procedures of biological knowledge. Teachers were of the opinion that students gain educational benefit from being required to take standardized tests. Teachers indicated that students showed a fair amount of enthusiasm for writing YUBAT. Teachers were least satisfied with the Test's capability to measure teacher effectiveness and they also indicated low satisfaction with the Test's strengths as a measure of a school's program in Biology.

Teacher opinion about the influence of YUBAT on the curriculum was that the content of the curriculum was likely to be influenced. However, little in the way of special preparation of students for the Test was likely. Teaching methods were unlikely to be influenced, and assessment methods even less so.

Teacher opinion about the use of YUBAT in the schools was that most teachers do not think YUBAT should be written by all grade 13 students. About a third of the teachers felt that it would be useful to have an external test such as YUBAT for use on a voluntary basis. Four-fifths of the teachers thought that YUBAT should be used only voluntarily.

ACHIEVEMENT OF YUBAT AIMS

The Task

The third task was to assess the extent to which the aims of YUBAT are being achieved.

Methodology

There was no definitive statement of YUBAT aims, and no simple criterion for judging the extent to which the Test is achieving its purposes. Rather, information identifying possible reasons for using the Test was collected by interviewing the teachers and York University faculty who had developed the Test, and by analysing York University records of the Test development period. As well, questions 35.1-35.17 of the survey instrument supplied information from teacher users.

Findings

In the York University records and the interviews with York University faculty, seven aims were identified. Two were seen to have been accomplished: to permit recognition of outstanding achievement by grade 13 Biology students, and to establish liaison between York University and the schools. One has ceased to be an aim: to identify possible students for York University. Four aims generally have not been achieved: to influence grade 13 Biology curriculum to provide greater uniformity among schools, to allow exemption from parts of York University courses, to help teachers assess their effectiveness in teaching Biology, and to improve the general visibility of York University science programs in the schools.

In the interviews with the teacher members of the YUBAT development committee two aims were identified. One was believed to have been accomplished: to use the Test as a vehicle to select top Biology students. Teachers had no opinion about whether the second aim had been achieved: to shape thinking about what ought to be taught in senior Biology.

Item 35 of the survey instrument solicited teacher user opinion on three general reasons for using YUBAT relating to the student, to the teacher, and to program planning. Although the results indicate a somewhat lukewarm response toward various reasons for using the Test,

the most highly rated reason was that YUBAT provides a high level of challenge to students. However, over half of the teachers felt the Test had no importance for helping guide students into post-secondary programs or to gain advanced admission to university. More than half the teachers thought the Test had some significance as an indicator of teacher competence, but that it was not important to use the Test as a help in planning their courses. Although half of the teachers indicated that one reason for using the Test was to pave the way for a return to province-wide Biology programs, more than half did not see YUBAT serving as a prototype for a return to province-wide exams.

PRINCIPAL AND SUPERVISORY OFFICER OPINION

The Task

The fourth task was to assess the value of the Test program in the opinions of principals and supervisory officers.

Methodology

Telephone interviews were conducted with seven principals and six supervisory officers in whose schools and jurisdictions YUBAT was administered. Questions were asked about current and potential YUBAT value. In addition, science coordinators from two of the school boards contacted during the course of the study offered information they had gathered on YUBAT usage and value. Furthermore, one science coordinator issued the investigators an invitation to attend a meeting of Biology department heads to ask questions about current and potential YUBAT value.

Findings

Two principals knew of YUBAT. Both currently favoured it as a device for comparing student performance. The potential value of YUBAT and of external achievement tests generally was seen by five principals in terms of comparing student, teacher, and program performance. Four supervisory officers knew of YUBAT. Two valued the Test currently for diagnostic purposes. One saw no value currently for the Test. One approved it currently but for neither diagnostic nor comparative purposes. Three supervisory officers saw potential value for YUBAT and general external testing, with three provisos: that process objectives were measured, that the norms were school board referenced, and that testing was not

rigid. Three supervisory officers viewed the potential value of YUBAT and external achievement testing as negative.

The school board research was split on the value of YUBAT. One board did not favour use of the Test because its students were adversely affected by the results of taking the Test. The other board favoured use of the Test because it was seen as a device to evaluate Biology curricula.

The Biology department heads generally saw no current value in writing the Test. The heads saw potential value only if the aim of advanced placement for students performing well on YUBAT was achieved, and if such opportunity was offered at other universities as well as York.

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Appendix A

SURVEY INSTRUMENT: FREQUENCY AND PERCENTAGE OF RESPONSES

SECTION I: BACKGROUND INFORMATION

Questions 1-8A: Circle the appropriate number in response to the questions.

1. In which of the following situations do you teach?

	Public School	Secondary School	Independent School
f	0	64	3
%	0	96	4

2. In what school board area are you teaching?

	East York	Scarborough	Etobicoke	York	Peel	North York	Toronto	York County	Other
f	1	11	6	6	12	13	8	7	3
%	1	16	9	9	18	19	12	10	4

3. How many years total teaching experience do you have?

	1-5	6-10	11-15	16+
f	2	15	30	20
%	3	22	45	30

4. How many years have you been teaching at secondary school?

	1-5	6-10	11-15	16+
f	3	15	29	20
%	4	22	43	30

5. How many years have you been teaching Grade 13 Biology?

	1-5	6-10	11-15	16+
f	10	30	18	9
%	15	45	27	13

6. What kind of Grade 13 Biology program do you teach?

	Regular	Approved Experimental	Both
f	60	3	4
%	90	4	6

7. What is the highest academic degree you now hold?

	Doctorate	Master's	Honours Bachelor's (4 year)	Bachelor's	Post-Secondary Diploma	Other
f	1	25	30	11	0	0
%	1	37	45	16	0	0

8. To which certification category do you belong?

	Type A	Type B
f	61	6
%	91	9

8A. What position did you hold when the York University Biology Achievement test was last administered to your students?

	Teacher without Administrative Responsibility	Assistant or Associate Department Head	Department Head
f	17	16	34
%	25	24	51

SECTION II: COURSE PLANNING AND INSTRUCTION

This section asks for information on course planning, student evaluation, instructional materials, and methodology. If you feel the alternatives provided are not adequate, please feel free to make additions or offer comments.

Questions 9.1-9.11: Apply the following responses and circle the corresponding response code.

9. Indicate to what extent the considerations listed below influence your teaching of Grade 13 Biology:

		Not At All	A Little	Somewhat	Considerably	A Great Deal
9.1 interests of students.....	f	3	12	24	18	9
	%	5	18	27	36	14
9.2 subject-matter background of students.....	f	2	8	20	30	6
	%	3	12	30	45	9
9.3 relationship between this course and others taken concurrently by students.....	f	8	16	25	12	4
	%	12	25	38	18	6
9.4 information on the courses, programs, and career choices of students after completing your course.....	f	8	9	21	20	8
	%	12	14	32	30	12
9.5 Ontario Ministry of Education Circular HS1: Secondary School Diploma Requirements.....	f	7	4	14	26	13
	%	11	6	22	41	20
9.6 Ontario Ministry of Education Curriculum Guideline: Biology grade 13, 1969.....	f	3	4	4	32	22
	%	5	6	6	49	34

		Not at All	A Little	Somewhat	Considerably	A Great Deal
9.7 course outline assigned to you.....	f	21	5	7	11	17
	%	34	8	11	18	28
9.8 your special interests or training.....	f	2	7	29	22	6
	%	3	11	44	33	9
9.9 content and approach of principal texts.....	f	6	17	22	17	4
	%	9	26	33	26	6
9.10 York University Biology Achievement Test.....	f	51	8	6	1	0
	%	77	12	9	2	0
9.11 other (please specify) 17/67	f	2	1	3	6	5
_____	%	12	6	18	35	29

Questions 10-11: Circle the appropriate number in response to the questions.

10. Are there required or strongly recommended prerequisites or corequisites for your Grade 13 Biology?

	Yes	No
f	66	1
%	99	1

11. If you answered "yes" to item 10 (above), identify which prerequisite or corequisite courses apply.

%	f	
27	18	General Science
60	40	Science - Biology
3	2	Mathematics
1	1	Biochemistry
81	54	Chemistry
6	4	Physics

Questions 12.1-13.8: Apply the responses and circle the corresponding response codes.

12. Indicate to what extent in your teaching of Grade 13 Biology you emphasize the general aims listed below:

			Not At All	A Little	Somewhat	Considerably	A Great Deal
12.1	the student should develop an attitude of scientific curiosity.....	f	0	5	17	34	11
		%	0	7	25	51	16
12.2	the student should develop an understanding of scientific methodologies.....	f	2	8	13	35	9
		%	3	12	19	52	13
12.3	the student should be able to demonstrate ability to:	f	3	13	16	29	5
12.3.1	define a biological problem.....	%	5	20	24	44	8
12.3.2	design an appropriate research program.....	f	15	25	16	8	3
		%	22	37	24	12	4
12.3.3	collect appropriate data.....	f	4	13	14	26	10
		%	6	19	21	39	15
12.3.4	organise and interpret the data.....	f	3	10	13	23	18
		%	4	15	19	34	27
12.3.5	communicate the results of the research program.....	f	9	7	18	24	9
		%	13	10	27	36	13

			Not At All	A Little	Somewhat	Considerably	A Greal Deal
12.4	the student should develop an understanding of agricultural and medical activities as applications of the principles of biology.....	f	4	13	21	19	9
		%	6	20	32	29	14
12.5	the student should be aware of the historical development of the ideas and concepts of biology.....	f	1	24	24	14	3
		%	2	36	36	21	5
12.6	the student should develop an awareness of the social correlatives of biological problems.....	f	1	9	16	30	10
		%	2	14	24	45	15
12.7	the student should develop an awareness of the potential in man to control his environment.....	f	2	5	16	29	14
		%	3	8	24	44	21
12.8	the student should be capable of utilising a variety of laboratory equipment.....	f	1	8	12	33	12
		%	2	12	18	50	18
12.9	the student should be able to utilise a variety of laboratory procedures, texts, and techniques.....	f	1	7	13	28	17
		%	2	11	20	42	26
12.10	the student should become familiar with the use of the microscope.....	f	3	3	6	27	27
		%	5	5	9	41	41
12.11	the student should be able to carry out valid field observation.....	f	10	16	22	11	7
		%	15	24	33	17	11

		Not At All	A Little	Somewhat	Considerably	A Great Deal
12.12 the student should be familiar with important "layman" journals such as Scientific American.....	f	0	19	25	15	8
	%	0	28	37	22	12
12.13 the student should be aware of and familiar in detail with some specialised research journals in selected fields of biology.....	f	18	24	19	3	3
	%	27	36	28	4	4
12.14 the student should be able to read critically research papers in some areas of biology.....	f	17	18	21	5	6
	%	25	27	31	7	9
12.15 the student should recognise the tentativeness of biological knowledge.....	f	1	4	22	28	11
	%	2	6	33	42	17
12.16 the student should demonstrate an ability to discuss the pros and cons of research in some area of biology.....	f	5	16	24	16	6
	%	7	24	36	24	9
12.17 the student should be able to write a discursive account of a problem in an area of biology, in essay form.....	f	10	9	21	23	4
	%	15	13	31	34	6
12.18 the student should be able to apply standard experimental methods.....	f	2	8	19	29	8
	%	3	12	29	44	12
13. To what extent do your students utilise the following resources in your Grade 13 Biology course?	f	0	3	13	19	31
13.1 one or more main texts.....	%	0	5	20	29	47

			Not At All	A Little	Somewhat	Considerably	A Great Deal
13.2	one or more main texts plus a variety of materials from other texts.....	f	4	10	15	25	11
		%	6	15	23	38	17
13.3	mimeographed notes.....	f	8	18	15	19	7
		%	12	27	22	28	10
13.4	reference books, dictionaries, encyclopedias, journals, etc.....	f	2	19	24	16	6
		%	3	28	36	24	9
13.5	individualised learning packages.....	f	31	17	9	7	2
		%	47	26	14	11	3
13.6	laboratory and/or computer equipment.....	f	5	14	16	21	9
		%	8	22	25	32	14
13.7	audiovisual media (tapes, T.V., film strips, etc.).....	f	1	15	22	18	10
		%	2	23	33	27	15
13.8	other (please specify) 9/58 _____ _____	f	0	1	4	3	1
		%	0	11	44	33	11

Questions 14-18: Circle the appropriate numbers in response to the questions.

If you use one or more primary texts in your Grade 13 Biology course, what is (are) their author(s) and title(s)?

Please circle 1, 2, or 3 OR fill in spaces and circle 4 or 5, OR an appropriate combination of 1 to 5.

	f	
	9	Penny and Waern, Biology: an Introduction....
	35	Galbraith, Biological Science: Principles and Patterns.
	3	B.S.C.S. (yellow version)
	44	
	6	

15. To what extent do you emphasize that students progress at their own rates?

	Not At All	A Little	Somewhat	Considerably	A Great Deal
f	20	22	21	3	0
%	30	33	32	5	0

16. Is it possible for students to be exempt from writing the final examination in Grade 13 Biology on the basis of term work?

	Yes	No	No Final Exam - School Policy
f	36	25	6
%	54	37	9

17. If you answered "yes" to item 16 (above), what is the single main basis for this exemption?

	Oral Tests	Written Tests	Oral and Written Tests	Research Program Performance
f	0	31	4	1
%	0	86	11	3

18. Given your own students' experience with testing, do you believe that in writing the York test they were at a:

	Considerable Disadvantage	Slight Disadvantage	Slight Advantage	Considerable Advantage
f	16	29	11	4
%	27	48	18	7

Questions 19.1-19.13: Apply the following responses and circle the corresponding response code.

19. For the following categories of assessment, estimate the percentage of the student's final grade normally allocated. The percentages should total approximately 100%.

		0-5%	6-10%	11-15%	16-20%	21-25%	26-40%	41-60%	61-80%
19.1 final examinations..	f	7	1	6	8	5	18	18	0
	%	11	2	10	13	8	29	29	0
19.2 mid-term examination(s).....	f	10	1	5	13	16	9	11	1
	%	15	2	8	20	24	14	17	2
19.3 other written tests.	f	3	2	7	11	16	17	7	3
	%	5	3	11	17	24	26	11	5
19.4 other oral tests....	f	43	4	0	1	0	0	1	0
	%	88	8	0	2	0	0	2	0
19.5 individual papers (essays, reports, etc.).....	f	16	16	12	5	6	4	1	1
	%	26	26	20	8	10	7	2	2
19.6 individual projects (oral presentations, e.g.).....	f	26	12	7	3	1	2	1	0
	%	50	23	13	6	2	4	2	0

			0-5%	6-10%	11-15%	16-20%	21-25%	26-40%	41-60%	61-80%
19.7	team or group papers, projects...	f	40	6	1	0	0	2	0	0
		%	82	12	2	0	0	4	0	0
19.8	problems, exercises	f	38	7	2	2	0	1	0	0
		%	76	14	4	4	0	2	0	0
19.9	notebooks.....	f	50	0	0	0	0	0	1	0
		%	98	0	0	0	0	0	2	0
19.10	laboratory and/or other class participation.....	f	26	13	13	2	4	3	0	0
		%	43	21	21	3	7	5	0	0
19.11	effort.....	f	43	11	1	0	0	0	1	0
		%	77	20	2	0	0	0	2	0
19.12	attendance.....	f	48	1	0	0	0	0	0	1
		%	96	2	0	0	0	0	0	2
19.13	other (please specify)...	f	3	0	0	2	0	0	0	0
		%	60	0	0	40	0	0	0	0

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Questions 20.1-25: Circle the appropriate number in response to the questions.

20. Has your knowledge of the content of one or more standardised achievement tests ever caused you to:

		Yes, on several occasions	Yes, on a few occasions	No
20.1 change your teaching method?	f	0	14	53
	%	0	21	79

		Yes, on several occasions	Yes, on a few occasions	No
20.2 change the content of your course?	f	0	18	48
	%	0	27	73
20.3 change your method of student assessment?	f	0	8	59
	%	0	12	88

21. If you discovered that a standardised achievement test which is used for admission at one or more universities differed in its emphases from the present content of your Grade 13 Biology course, would you:

21.1 change your teaching method?	f	9	22	36
	%	13	33	54
21.2 change the content of your course?	f	19	35	13
	%	28	52	19
21.3 change your method of student assessment?	f	4	20	43
	%	6	30	64

22. Do you feel that students in general get educational benefit from being required to take standardised tests?

	Yes	No
f	41	26
%	61	39

23. Have you ever made an effort to prepare your students specifically for writing the York University Biology Achievement Test?

	Yes-major part of course designed for this	Yes-minor part of course designed for this	Yes - Occasionally	No
f	0	0	8	59
%	0	0	12	88

		Yes, frequently	Yes, occasionally	Yes, once or twice	No, never
24. Have you ever conducted a special class designed to prepare students specifically for the York University Biology Achievement Test?	f	0	1	5	61
	%	0	1	7	91
25. Have you ever coached specific students in preparation for the York University Biology Achievement Test?	f	0	1	3	62
	%	0	2	5	94

Questions 26-27.13: Apply the following responses and circle the corresponding response code.

		Poor	Fair	Good	Very Good	Excellent
26. Indicate your overall satisfaction with the York University Biology Achievement Test.....	f	12	20	17	11	5
	%	18	31	26	17	8
27. Indicate your satisfaction with the following aspects of the York University Biology Achievement Test:	f	4	9	15	25	12
27.1 multiple-choice format.....	%	6	14	23	38	18
	f	11	25	15	6	6
27.2 choice of items.....	%	17	40	24	10	10
	f	13	11	23	9	7
27.3 number of items.....	%	21	17	37	14	11
	f	21	8	19	12	5
27.4 time of year test was administered.....	%	32	12	29	18	8

			Poor	Fair	Good	Very Good	Excellent
27.5	level of difficulty.....	f	9	10	21	14	8
		%	15	16	34	23	13
27.6	level and amount of detail in test.....	f	10	15	15	13	5
		%	17	26	26	22	9
27.7	level and amount of concepts, theories, and principles in the test.....	f	8	11	20	13	7
		%	14	19	34	22	12
27.8	the test's ability to indicate the student's achievement in terms of:						
	27.8.1 biology content knowledge.....	f	4	10	20	20	7
		%	7	16	33	33	11
	27.8.2 research skills in biology.....	f	13	15	17	8	2
		%	24	27	31	15	4
	27.8.3 understanding biology..	f	3	14	18	15	8
		%	5	24	31	26	14
	27.8.4 application of biological principles..	f	1	14	21	15	7
		%	2	24	36	26	12
	27.8.5 synthesizing elements and components to constitute the structure of the whole of biology.....	f	7	21	13	8	4
		%	13	40	25	15	8

		Poor	Fair	Good	Very Good	Excellent
27.8.6 ability to evaluate principles, applications, limitations and research procedures of biological knowledge..	f	4	22	17	9	2
	%	7	41	31	17	4
27.8.7 ability to investigate and generalise about a wide range of biological problems...	f	4	20	21	8	2
	%	7	36	38	15	4
27.9 value as a measure of teacher effectiveness.....	f	28	17	11	5	1
	%	45	27	18	8	2
27.10 value as a measure of a school's program in biology....	f	25	20	11	3	4
	%	40	32	17	5	6

Questions 28-34: Circle the appropriate number in response to the questions.

28. Would you recommend that the York University Biology Achievement Test be used by:

	All Grade 13 Biology teachers	Only those who want to	No one
f	10	49	5
%	16	77	8

29. Would you recommend that the York University Biology Achievement Test be written by:

	All Grade 13 Biology students	Only the top students	Only those students picked by the teacher	Only those who want to write the test
f	9	3	2	50
%	14	5	3	78

30. In awarding students marks in Grade 13 Biology, do you believe that there should be:

	f	%
No change from current practices.	31	47
Voluntary use of one or more external tests such as the York University Biology Achievement Test.	21	32
Required use of one or more external tests such as the York University Biology Achievement Test to provide all or part of the Grade 13 Biology mark.	13	20

31. If an external examination was to be prepared in Grade 13 Biology, the best group to prepare the test would be:

	The Ontario Ministry of Education.	University Departments of Biology.	A teacher committee.	Teachers in cooperation with the Ontario Ministry of Education.	Teachers in cooperation with University Departments of Biology.	Ontario Ministry of Education in cooperation with University Departments of Biology.	Cooperation among teachers, Ontario Ministry of Education, and University Departments of Biology.
f	0	1	6	4	14	1	41
%	0	1	9	6	21	1	61

32. How enthusiastic were your students about taking the test?

	Not At All	A Little	Somewhat	Considerably	Very
f	8	26	20	12	1
%	12	39	30	18	1

33. When your students received their scores on the York University Biology Achievement Test, how generally were they affected?

	Positively	Negatively	Neutrally
f	21	13	30
%	33	20	47

34. In your opinion, how did writing the York University Biology Achievement Test affect student interest in pursuing further studies in Biology?

	Positively	Negatively	Neutrally
f	9	5	51
%	14	8	78

Questions 35.1-35.17: Apply the following responses and circle the corresponding response code.

35. What degree of importance to you attach to each of the following possible reasons for using the York University Biology Achievement Test:

		Not At All	A Little	Somewhat	Considerably	A Great Deal
35.1 measure the level of achievement for individual students...	f	9	12	25	16	5
	%	13	18	37	24	7

			Not At All	A Little	Somewhat	Considerably	A Great Deal
35.2	help in guiding students into appropriate post-secondary programs.....	f	38	15	11	3	0
		%	57	22	16	4	0
35.3	compare your students' scores with those in other schools....	f	18	11	17	13	7
		%	27	17	26	20	11
35.4	help students gain a better understanding of their strengths and weaknesses.....	f	13	18	20	12	3
		%	20	27	30	18	5
35.5	help determine the significance to your Grade 13 Biology program.....	f	22	12	20	7	4
		%	34	18	31	11	6
35.6	a valid indicator of student learning.....	f	18	24	16	6	3
		%	27	36	24	9	4
35.7	a valid indicator of teacher competance.....	f	27	20	14	4	1
		%	41	30	21	6	2
35.8	helps you plan your course.....	f	40	10	13	3	1
		%	60	15	19	4	1
35.9	a diagnostic instrument for your students.....	f	27	18	14	7	0
		%	41	27	21	11	0
35.10	serves to identify strengths and weaknesses in your Grade 13 Biology course.....	f	26	16	12	12	1
		%	39	24	18	18	1
35.11	can identify outstanding achievement at least as well or better than you can.....	f	22	13	15	14	3
		%	33	19	22	21	4

			Not At All	A Little	Somewhat	Considerably	A Great Deal
35.12	serves to select scholarship students in Biology.....	f	23	10	12	18	4
		%	34	15	18	27	6
35.13	provides a high level challenge to your students.....	f	11	9	17	23	7
		%	16	13	25	34	10
35.14	serves to encourage young talent in Biology.....	f	26	17	10	12	2
		%	39	25	15	18	3
35.15	serves as a prototype to prepare you for a return to a province-wide uniform Biology program....	f	33	11	9	9	4
		%	50	17	14	14	6
35.16	provides for the possibility of some of your students gaining advanced admission status at York University.....	f	34	12	12	7	1
		%	52	18	18	11	2
35.17	no special reason but saw no harm in using the test.....	f	17	3	9	15	15
		%	29	5	15	25	25

Questions 36-38: Circle the appropriate number in response to the questions.

36. For the reason that your students would be better prepared to write the York University Biology Achievement Test, have you ever been asked by your principal or department head to:

			Yes, on several occasions	Yes, on a few occasions	No
36.1	change your teaching method?	f	0	1	66
		%	0	1	99

		Yes, on several occasions	Yes, on a few occasions	No
36.2 change the content of your course?	f	0	2	65
	%	0	3	97
36.3 change your method of student assessment?	f	0	2	65
	%	0	3	97
37. For the reason that your students would be better prepared to write the York University Biology Achievement Test, have you ever been asked by your Grade 13 Biology students to:				
37.1 change your teaching method?	f	0	0	67
	%	0	0	100
37.2 change the content of your course?	f	0	3	64
	%	0	4	96
37.3 change your method of student assessment?	f	0	0	67
	%	0	0	100
38. Have you ever used items from the York University Biology Achievement Test on your own Grade 13 Biology tests?	f	2	10	54
	%	3	15	82

SECTION III: COURSE CONTENT

The "Biology Content Matrix" which follows on pp. 23-31 contains a list of topics treated in Grade 13 Biology courses. There are 54 topical items in this table. These have been arranged in nine sections as indicated below.

Section	Title	No. of Items
I	Characteristics of Living Things	4
II	Cells	5
III	Organisms	19
IV	Classification of Organisms	4
V	Interdependence of Organisms	6
VI	Heredity and Variation: Genetic Continuity	5
VII	Evolution: Changes in Living Things Through Time	4
VIII	Nature of Science	3
IX	Bacteria and Viruses	4

You are asked to make entries in <u>two</u> columns of the matrix.

<u>Column 1</u> is concerned with the amount of class time you allocate to the topic items. The responses among which you are asked to select in Column 1 deal with the number of periods that you spend teaching each of these items. Please make sure the total number of periods you allocate corresponds to the total number of periods in the course.

<u>Column 2</u> (beside Column 1) is concerned with the average level of competence you believe was achieved by your students in the topic items, at the end of the Grade 13 Biology course. We have chosen a five-point response scale on the following basis, with the competence of the average student as a focus.

Response Scale	Competence
1	Descriptive knowledge only.
2	Basic understanding, elementary research skills.
3	Simple application of principles.
4	Thorough understanding, can work with pieces, elements, parts to synthesize them into patterns for discerning problems.
5	Complete mastery, evaluation of research procedures and principles of biological knowledge, and their application and limitations.

In assigning each level of response, please keep in mind the wide range between descriptive knowledge only (scale #1) and complete mastery (scale #5). Furthermore, there may be topics relevant to your course which are not on the list. If so, please add them at the end of the list and respond in both columns to them. In answering question 40, please use whatever course outlines, student assignments, texts, and other resources you may have that might assist you.

Question 39: Enter the appropriate number.

39. How many Grade 13 Biology periods do you teach per year in a single course? ☐

Questions 40.1-40.54: Apply the following responses and circle the corresponding response codes in both column 1 and column 2 of this Biology Content Matrix.

TOPICS		COLUMN 1 Number of Periods							COLUMN 2 Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
I *Characteristics of Living Things*													
40.1 movement..	f	9	45	4	1	0	0	0	18	16	18	4	0
	%	15	76	7	2	0	0	0	32	29	32	7	0
40.2 irritability.....	f	11	43	5	1	0	0	0	17	19	17	5	0
	%	18	72	8	2	0	0	0	29	33	29	9	0
40.3 reproduction.....	f	10	40	5	4	0	0	0	17	17	18	5	0
	%	17	68	8	7	0	0	0	30	30	32	9	0
40.4 metabolism	f	9	43	4	1	3	1	0	16	16	17	7	1
	%	15	70	7	2	5	2	0	28	28	30	12	2
II *Cells*													
40.5 structure.	f	1	15	22	17	6	1	0	9	13	17	22	1
	%	2	24	35	27	10	2	0	15	21	27	35	2
40.6 physical properties of protoplasm.....	f	5	44	11	2	0	0	0	13	20	18	10	0
	%	8	71	18	3	0	0	0	21	33	30	16	0
40.7 physical properties of cell membrane..	f	2	29	25	6	0	0	0	5	14	21	20	2
	%	3	47	40	10	0	0	0	8	23	34	32	3
40.8 mitosis...	f	4	32	23	3	0	0	0	3	14	26	17	1
	%	6	52	37	5	0	0	0	5	23	43	28	2

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.9 chemical properties.	f	5	16	12	6	8	2	8	8	15	19	14	1
	%	9	28	21	11	14	4	14	14	26	33	25	2
III *Organisms*													
A. Study of Animals (Zoology)													
40.10 digestion..	f	1	10	20	21	8	0	0	3	11	19	19	6
	%	2	17	33	35	13	0	0	5	19	33	33	10
40.11 circulation	f	3	10	18	13	14	2	0	4	9	22	17	5
	%	5	17	30	22	23	3	0	7	16	39	30	9
40.12 respiration	f	1	17	21	13	7	0	0	2	11	23	18	5
	%	2	29	36	22	12	0	0	3	19	39	31	8
40.13 excretion..	f	2	19	28	6	5	0	0	3	15	20	16	5
	%	3	32	47	10	8	0	0	5	25	34	27	8
40.14 locomotion.	f	9	21	18	7	4	1	0	6	14	18	14	3
	%	15	35	30	12	7	2	0	11	25	33	25	5
40.15 reproduction.....	f	1	17	28	9	4	1	0	5	14	23	13	4
	%	2	28	47	15	7	2	0	8	24	39	22	7

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.16 coordinating system.....	f	6	9	17	16	10	2	1	3	15	19	16	3
	%	10	15	28	26	16	3	2	5	27	34	29	5
40.17 behaviour...	f	28	20	9	2	2	0	0	4	17	11	2	4
	%	46	33	15	3	3	0	0	11	45	29	5	11
40.18 development, homeostasis, bio-chemistry, tissues.....	f	2	8	14	16	8	9	3	6	13	15	14	8
	%	3	13	23	27	13	15	5	11	23	27	25	14
B. Study of Plants (Botany)													
40.19 supporting system.....	f	23	33	5	1	0	0	0	10	15	13	4	0
	%	37	53	8	2	0	0	0	24	36	31	10	0
40.20 anchorage...	f	27	33	3	0	0	0	0	11	12	13	3	0
	%	43	52	5	0	0	0	0	28	31	33	8	0
40.21 absorption of materials...	f	19	35	7	1	1	0	0	9	17	14	4	0
	%	30	56	11	2	2	0	0	20	39	32	9	0
40.22 conducting system.....	f	20	31	9	2	0	0	0	10	15	15	4	0
	%	32	50	15	3	0	0	0	23	34	34	9	0

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.23 growth.....	f	24	31	5	0	0	0	0	9	15	11	4	0
	%	40	52	8	0	0	0	0	23	38	28	10	0
40.24 gas exchange system.....	f	16	37	8	0	0	0	0	9	16	17	6	0
	%	26	61	13	0	0	0	0	19	33	35	13	0
40.25 photosynthesis system.....	f	3	15	21	15	7	1	0	3	10	22	17	4
	%	5	24	34	24	11	2	0	5	18	39	30	7
40.26 food storage system.....	f	27	28	6	0	0	0	0	10	14	11	3	0
	%	44	46	10	0	0	0	0	26	37	29	8	0
40.27 reproduction	f	18	30	13	1	0	0	0	7	18	16	4	0
	%	29	48	21	2	0	0	0	16	40	36	9	0
40.28 coordinating system.....	f	28	21	11	2	0	0	0	4	9	16	5	0
	%	45	34	18	3	0	0	0	12	26	47	15	0
IV *Classification of Organisms*													
40.29 history of systematics.	f	44	17	1	1	0	0	0	10	4	6	2	0
	%	70	27	2	2	0	0	0	45	18	27	9	0

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
	f	43	16	2	0	0	0	0	8	3	7	3	0
40.30 systematics	%	70	26	3	0	0	0	0	38	14	33	14	0
	f	34	24	4	0	0	0	0	8	10	8	2	1
40.31 principle of classification..	%	55	39	6	0	0	0	0	28	34	28	7	3
	f	40	18	3	0	0	0	0	4	3	13	3	1
40.32 use of taxonomy key..	%	66	30	5	0	0	0	0	17	13	54	13	4
V *Interdependence of Organism*													
40.33 photosynthesis fixes energy.....	f	15	21	15	7	2	1	1	4	12	14	13	4
	%	24	34	24	11	3	2	2	9	26	30	28	9
40.34 food chains and energy flow.....	f	29	16	10	2	1	1	1	5	9	7	8	4
	%	48	27	17	3	2	2	2	15	27	21	24	12
40.35 communities and succession	f	34	16	9	1	1	1	0	5	11	7	6	3
	%	55	26	15	2	2	2	0	16	34	22	19	9

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.36 factors affecting population size.....	f	39	17	7	0	0	0	0	5	10	8	1	3
	%	62	27	11	0	0	0	0	19	37	30	4	11
40.37 special relationships (mutualism, parasitism, etc.).....	f	34	24	5	0	0	0	0	7	10	10	9	2
	%	54	38	8	0	0	0	0	22	31	31	9	6
40.38 influence of man in the environment	f	33	22	3	3	0	2	0	7	6	10	2	7
	%	52	35	5	5	0	3	0	22	19	31	6	22
VI *Heredity and Variation: Genetic Continuity*													
40.39 reproduction as a phenomenon.	f	8	36	12	3	2	0	0	8	18	15	9	0
	%	13	59	20	5	3	0	0	16	36	30	18	0
40.40 meiosis and heredity...	f	6	15	26	9	5	1	0	11	22	16	4	0
	%	10	24	42	15	8	2	0	21	42	30	8	0
40.41 biochemical basis of heredity...	f	6	18	25	7	7	0	0	2	14	19	12	5
	%	10	29	40	11	11	0	0	4	27	37	23	10

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.42 principles of heredity	f	13	10	27	5	6	1	0	2	13	19	11	5
	%	21	16	44	8	10	2	0	4	26	38	22	10
40.43 population genetics...	f	27	19	11	4	0	0	0	6	9	14	4	4
	%	44	31	18	7	0	0	0	16	24	38	11	11
VII *Evolution: Changes in Living Things Through Time*													
40.44 Darwin's Theory.....	f	21	32	10	0	0	0	0	9	16	13	4	1
	%	33	51	16	0	0	0	0	21	37	30	9	2
40.45 mechanism of evolution..	f	18	28	14	3	0	0	0	7	14	13	10	0
	%	29	44	22	5	0	0	0	16	32	30	23	0
40.46 application in improving varieties of domestic plants and animals....	f	29	27	4	0	0	0	0	7	14	8	6	0
	%	48	45	7	0	0	0	0	20	40	23	17	0
40.47 hominid evolution..	f	43	14	2	1	1	0	0	8	8	0	5	0
	%	70	23	3	2	2	0	0	38	38	0	24	0

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
VIII *Nature of Science*	f	35	16	3	2	1	2	0	3	7	9	1	4
40.48 nature of inquiry and experiments	%	59	27	5	3	2	3	0	13	29	38	4	17
40.49 history....	f	42	11	3	1	2	0	0	9	8	2	0	1
	%	71	19	5	2	3	0	0	45	40	10	0	5
40.50 application	f	44	8	5	1	0	0	0	6	5	5	1	2
	%	76	14	9	2	0	0	0	32	26	26	5	11
IX *Bacteria and Viruses*	f	50	8	0	0	0	0	0	6	4	2	1	0
40.51 history....	%	86	14	0	0	0	0	0	46	31	15	8	0
40.52 methodology	f	49	6	1	1	0	0	0	6	3	3	1	0
	%	86	11	2	2	0	0	0	46	23	23	8	0
40.53 characteristics.....	f	35	22	2	0	0	0	0	10	13	5	1	0
	%	59	37	3	0	0	0	0	34	45	17	3	0
40.54 application	f	43	11	2	0	0	0	0	6	9	2	1	0
	%	77	20	4	0	0	0	0	33	50	11	6	0

		COLUMN 1							COLUMN 2				
		Number of Periods							Level Attained With Last Grade 13 Biology Class				
		Not Covered	1-2	3-5	6-8	9-15	16-25	26+	Descriptive Knowledge	Understanding	Application	Synthesis	Evaluation
40.55 other (please specify)___													
_____	f	1	7	3	11	3	4	0	0	3	13	7	4
_____	%	3	24	10	38	10	14	0	0	11	48	26	15
_____													
40.56 other (please specify)___													
_____	f	1	3	6	5	3	0	0	0	3	9	3	2
_____	%	6	17	33	28	17	0	0	0	18	53	18	12
_____													
40.57 other (please specify)___													
_____	f	1	2	2	4	0	0	0	0	0	7	0	1
_____	%	11	22	22	44	0	0	0	0	0	88	0	13
_____													

Question 41: Circle the appropriate number in response to the question.

41. Look back in question 40 at areas on which you spend the least time. Is the general reason for this that you expect your students to have covered those areas in other related courses?

	Yes	No
f	48	12
%	80	20

****

PLEASE SEND BACK YOUR COMPLETED QUESTIONNAIRE IN THE ENCLOSED RETURN ENVELOPE BY OCTOBER 17 , 1977. IT IS VERY IMPORTANT THAT WE RECEIVE YOUR QUESTIONNAIRE, AS INDIVIDUAL TEACHER'S OPINIONS ARE CRUCIAL FOR CONDUCTING A MEANINGFUL INVESTIGATION. THANK YOU VERY MUCH FOR THE PATIENCE, EFFORT, AND TIME WHICH YOU HAVE CONTRIBUTED.

Appendix B

APPENDIX TABLES 1-7

APPENDIX TABLE 1

Guideline Unit Analysis of YUBAT

Content Area	Test Item Number	Number of Entries	Percentage of Total Entries
Unit 1. Characteristics of Living Things			
1. Movement	135	1	
2. Irritability			
3. Reproduction	150	1	
4. Metabolism	1; 23; 140	3	
	Subtotals:	5	2
Unit 2. Cells			
1. Structures	81; 83; 97; 154; 155	5	
2. Physical properties	19; 35; 36; 76; 117; 125; 132; 133; 166; 194; 195; 196; 205	13	
3. Mitosis	10; 22; 48; 80; 81; 128; 167; 168	8	
4. Added category (chemical properties, functions)	11; 12; 24; 35; 36; 39; 44; 49; 51; 59; 64; 68; 70; 73; 84; 117; 118; 119; 132; 137; 142; 152; 153; 165; 172; 181; 183; 195; 203; 208	30	
	Subtotals:	56	24
Unit 3. Organisms			
1. Zoology			
1.1 Digestion	15; 26; 57; 120; 121; 122; 123	7	
1.2 Circulation	19; 21; 29; 107; 113; 130; 157; 174; 177; 186; 196; 201	12	
1.3 Respiration	64; 134; 139; 196; 204	5	
1.4 Excretion	14; 72; 129; 188; 199; 212	6	

APPENDIX TABLE 1 (continued)

Content Area	Test Item Number	Number of Entries	Percentage of Total Entries
Unit 3. Organisms (contd.)			
1.5 Locomotion	3; 28; 41; 42; 54; 58; 68; 170; 192	9	
1.6 Reproduction	4; 98; 99; 100; 106	5	
1.7 Coordination	2; 34; 116; 117; 131; 149; 164; 187; 200	9	
1.8 Added category (development biochemistry, tissues)	7; 17; 18; 20; 65; 66; 71; 74; 75; 77; 78; 101; 102; 103; 107; 148; 176; 186	18	
	Subtotals:	71	31
2. Botany			
2.1 Supporting system	91; 112	2	
2.2 Anchorage	109	1	
2.3 Absorption	88; 110; 143	3	
2.4 Conducting System	45; 55; 111	3	
2.5 Growth	112; 211	2	
2.6 Gas Exchange	67	1	
2.7 Photosynthesis	67; 89; 90; 124; 178; 179; 206; 208	8	
2.8 Food Storage	108	1	
2.9 Reproduction	32; 38	2	
2.10 Coordination			
	Subtotals:	23	10
Unit 4. Classification			
1. History			
2. Principles	33; 87; 106; 147; 190; 202	6	
3. Use of Key	13; 25; 86; 92; 93; 94; 95; 96	8	
	Subtotals:	14	6

APPENDIX TABLE 1 (continued)

Content Area	Test Item Number	Number of Entries	Percentage of Total Entries
Unit 5: Interdependence of Organisms			
1. Photosynthesis	89; 90; 124	3	
2. Foodchain	16; 37; 46; 146; 189	5	
3. Communities	163	1	
4. Population size	47; 159; 160; 161; 162; 168; 173; 184	8	
5. Special relationships	201	1	
6. Influence of Man			
	Subtotals:	18	8
Unit 6: Heredity			
1. Reproduction	5; 63; 106	3	
2. Meiosis	31; 126; 144; 154; 169; 198; 210	7	
3. Added category (biochemical basis, laws)	5; 8; 9; 27; 30; 50; 56; 60; 61; 62; 69; 115 127; 136; 138; 145; 151; 152; 156; 180; 197	21	
	Subtotals:	31	13
Unit 7: Evolution			
1. Darwin's Theory and others	43; 185; 297	3	
2. Mechanics	6; 14; 52; 53; 104; 193	6	
3. Application			
4. Added category (evidence)	40; 43; 52; 175	4	
	Subtotals:	13	6
	GRAND TOTALS:	231	100

APPENDIX TABLE 2

Classification of YUBAT Items by York University[1]

Classification[2]	Number of Items[3]
1. taxonomy	14
2. genetics	22
3. evolution	9
4. ecology	15
5. biochemistry	24
6. gas exchange	2
7. all biology	11
8. physiology	12
9. development	7
10. morphology	10
11. hormones	19
12. respiration	4
13. absorption	11
14. digestion	3
15. mitosis	6
16. meiosis	4
17. reproduction	8
22. life cycles	2
23. locomotion	8
24. homeostasis	1
25. nutritive strategy	1
26. tissue	4
50. general	1
51. microscope	3
52. behavior	3
53. nervous	8
54. circulation	13
55. excretion	7
59. skeletal	4
70. photosynthesis	7
71. transport	3
72. growth	1
84. zoology	92
85. botany	32

[1]Information received from D. Farquhar.

[2]Intermittent numbering is York's.

[3]Total number of items exceeds 212 due to cross references.

APPENDIX TABLE 3[1]

Classification of YUBAT Items According to
Selected Content Emphases and Cognitive Levels

Item Number	Selected Content Emphases						Cognitive Levels				
	Biochemistry[2]	Zoology/Botany[3]	Genetics	Scientific Method	Ecology[4]	Homeostasis[5]	Knowledge	Understanding	Application	Synthesis	Evaluation
1						X		X			
2		Z					X				
3	X	Z					X				
4		Z					X				
5	X		X						X		
6							X				
7		Z					X				
8	X		X						X		
9	X		X						X		
10							X				
11	X						X				
12	X						X				
13		Z							X		
14		Z							X		
15	X	Z				X		X			
16					X			X			
17		Z					X				
18							X				
19		Z							X		
20		Z					X				
21		Z				X		X			
22							X				
23	X							X			
24	X						X				
25		Z						X			
Subtotal:	9	Z=12	3		1	3	13	6	6		

[1]Conversion to percent is based on total items of 212.

[2]York University lists only 11% biochemical test items (Appendix Table 2). However, their categories 7,8,11, and 70 (cell biology, physiology, hormones, and photosynthesis) contain items that are primarily biochemical in orientation. Their adjusted figures yield 34% of item entries.

[3]York University's ratio of Zoology:Biology (Appendix Table 2) is 92:32 or 2.87:1.

[4]York University (Appendix Table 2) classifies 15 items (category 4) or 7% as ecological.

[5]York University (Appendix Table 2) classifies only 1 item (category 24), less than 1% as homeostasis.

APPENDIX TABLE 3 (continued)

Classification of YUBAT Items According to
Selected Content Emphases and Cognitive Levels

Item Number	Biochemistry	Zoology/Botany	Genetics	Scientific Method	Ecology	Homeostasis	Knowledge	Understanding	Application	Synthesis	Evaluation
26		Z					X				
27		Z	X					X			
28		Z					X				
29		Z					X				
30		B	X						X		
31			X				X				
32		B					X				
33	X	B					X				
34	X	Z					X				
35		Z						X			
36								X			
37					X		X				
38		B					X				
39	X						X				
40		B					X				
41		Z						X			
42	X	Z							X		
43											X
44	X						X				
45		B					X				
46					X			X			
47								X			
48							X				
49	X						X				
50		Z	X						X		
51	X						X				
52								X			
53		Z						X			
54		Z							X		
55		B							X		
56		Z	X						X		
57	X	Z				X	X				
58		Z					X				
59	X	Z					X				
60		Z	X						X		
61		Z	X						X		
62		Z	X						X		
Subtotal:	9	Z=18 B=7	8		2	1	19	8	9		1

APPENDIX TABLE 3 (continued)

Classification of YUBAT Items According to
Selected Content Emphases and Cognitive Levels

Item Number	Biochemistry	Zoology/Botany	Genetics	Scientific Method	Ecology	Homeostasis	Knowledge	Understanding	Application	Synthesis	Evaluation
63		B	X				X				
64	X						X				
65		Z				X	X				
66	X	Z				X	X				
67		B					X				
68	X	Z				X		X			
69			X						X		
70	X	Z					X				
71	X	Z					X			X	
72		Z					X				
73	X						X				
74	X	Z					X				
75	X	Z					X				
76				X				X			
77	X	Z								X	
78	X	Z				X	X				
79	X	Z						X			
80											X
81									X		
82		Z							X		
83							X				
84	X						X				
85		Z					X				
86		Z					X				
87		Z						X			
88		B						X			
89	X	B		X				X			
90	X	B		X				X			
91		B					X				
92		B					X				
93		B					X				
94		B					X				
95		B					X				
96		B					X				
97				X			X				
98	X	Z					X				
99	X	Z					X				
100	X	Z					X				
Subtotal:	17	Z=18 B=11	2	4		4	25	7	3	2	1

APPENDIX TABLE 3 (continued)

Classification of YUBAT Items According to
Selected Content Emphases and Cognitive Levels

Item Number	Biochemistry	Zoology/Botany	Genetics	Scientific Method	Ecology	Homeostasis	Knowledge	Understanding	Application	Synthesis	Evaluation
101		Z		X		X		X			
102		Z		X		X		X			
103	X	Z		X		X				X	
104							X				
105	X						X				
106			X				X				
107	X	Z				X	X				
108		B					X				
109		B					X				
110		B					X				
111		B					X				
112		B					X				
113		Z					X				
114							X				
115			X						X		
116		Z						X			
117	X	Z						X			
118	X						X				
119	X						X				
120	X	Z					X				
121	X	Z					X				
122	X	Z					X				
123	X	Z					X				
124	X	B								X	
125							X				
126		Z	X				X				
127			X							X	
128							X				
129		Z				X				X	
130		Z					X				
131	X	Z					X				
132	X									X	
133										X	
134	X	Z					X				
135				X			X				
136		Z	X							X	
137	X						X				
Subtotal:	15	Z=17 B=6	5	4		5	25	4	1	7	

APPENDIX TABLE 3 (continued)

Classification of YUBAT Items According to Selected Content Emphases and Cognitive Levels

Item Number	Biochemistry	Zoology/Botany	Genetics	Scientific Method	Ecology	Homeostasis	Knowledge	Understanding	Application	Synthesis	Evaluation
138		Z	X						X		
139	X	Z				X	X				
140	X							X			
141		Z							X		
142	X						X				
143		B				X	X				
144			X					X			
145		Z	X					X			
146							X				
147							X				
148							X				
149		Z					X				
150							X				
151	X	B	X				X				
152	X		X				X				
153	X							X			
154			X				X				
155							X				
156			X							X	
157		Z				X	X				
158		Z						X			
159				X				X			
160				X	X			X			
161				X	X			X			
162				X				X			
163		B					X				
164		Z					X				
165	X						X				
166							X				
167							X				
168										X	
169			X					X			
170		Z					X				
171	X						X				
172	X						X				
173					X		X				
174	X	Z					X				
175		Z					X				
Subtotal:	10	Z=11 B=3	8	4	3	3	24	10	2	2	

APPENDIX TABLE 3 (continued)

Classification of YUBAT Items According to Selected Content Emphases and Cognitive Levels

Item Number	Biochemistry	Zoology/Botany	Genetics	Scientific Method	Ecology	Homeostasis	Knowledge	Understanding	Application	Synthesis	Evaluation
176		Z						X			
177		Z					X				
178	X	B		X				X			
179	X	B		X				X			
180		Z	X					X			
181	X						X				
182				X			X				
183		Z						X			
184					X				X		
185		Z							X		
186	X	Z				X	X				
187	X	Z					X				
188		Z				X		X			
189					X		X				
190	X	Z					X				
191	X	Z				X			X		
192	X	Z		X			X				
193		B						X			
194	X							X			
195	X						X				
196	X	Z					X				
197			X					X			
198			X					X			
199	X	Z					X				
200		Z					X				
201					X			X			
202		Z					X				
203	X						X				
204	X	Z							X		
205		B					X				
206	X	B						X			
207								X			
208	X	B					X				
209		Z					X				
210			X				X				
211		B							X		
212		Z						X			
Subtotal:	16	Z=18 B=7	4	4	3	3	18	14	5		
Total:	76	Z=94 B=34	30	16	9	19	124	49	26	11	2
Percentage:	36	Z=2.76 B=1	14	8	4	9	59	23	12	5	1

APPENDIX TABLE 4

Teachers' Courses of Study[1]: Guideline Unit Analysis and Selected Content Emphasis Analysis

Content Area	Guideline Unit Analysis (% of Course Time Allocated)
Unit 1: Characteristics of Living Things	
1. Movement	1
2. Irritability	1
3. Reproduction	1
4. Metabolism	2
Subtotal:	5
Unit 2: Cells	
1. Structure	4
2. Physical properties	3
3. Mitosis	2
4. Added category (chemical properties, functions)	6
Subtotal:	15
Unit 3: Organisms	
1. Zoology	
1.1 Digestion	4
1.2 Circulation	5
1.3 Respiration	4
1.4 Excretion	3
1.5 Locomotion	2
1.6 Reproduction	3
1.7 Coordination	4
1.8 Added category (development, homeostasis, biochemistry, tissues)	8
Subtotal:	33

[1]Unit 8 is a non-guideline unit included in the Guideline Unit Analysis Framework of the Survey Instrument to elicit information about teacher emphasis on Scientific Methodology. The total % of course time allocated is less than 100% because Unit 8 and two other units were added to the Survey Instrument.

APPENDIX TABLE 4 (continued)

Content Area	Guideline Unit Analysis (% of Course Time Allocated)
Unit 3: Organisms contd.	
2. Botany	
2.1 Supporting system	1
2.2 Anchorage	1
2.3 Absorption	1
2.4 Conducting system	1
2.5 Growth	1
2.6 Gas exchange	1
2.7 Photosynthesis	4
2.8 Food storage	1
2.9 Reproduction	1
2.10 Coordination	1
Subtotal:	13
Unit 4: Classification	
1. History	1
2. Principles	1
3. Use of Key	<1
Subtotal:	2
Unit 5: Interdependence	
1. Photosynthesis	2
2. Foodchain	1
3. Communities	1
4. Population size	1
5. Special relationships	1
6. Influence of man	1
Subtotal:	7
Unit 6: Heredity	
1. Reproduction	2
2. Meiosis	3
3. Added category (biochemical basis, laws)	7
	12

APPENDIX TABLE 4 (continued)

Content Area	Guideline Unit Analysis (% of Course Time Allocated).
Unit 7: Evolution	
1. Darwin's theory and others	1
2. Mechanics	1
3. Application	1
4. Added category (evidence)	1
Subtotal:	4
Grand Total:	91
Unit 8: Nature of Science	
8.1 Nature of inquiry	2
8.2 History	1
8.3 Application	<1
Subtotal:	3
Summary of Selected Content Emphases Analysis:	
Zoology Botany ratio (Unit 3 data)	Z=33 B=13
Genetics (Unit 6 data)	12
Scientific Method (Unit 8 data)	3
Ecology (Unit 5 data)	7

APPENDIX TABLE 5

Biochemistry and Homeostasis Emphasis in Submitted Course Outlines[1, 2, 3, 4]

Course Outline	Basis for Estimate of Emphasis	Biochemistry Emphasis	Homeostasis Emphasis
A	Unit outline & text chapter no.	1/3	part of 1 unit
B	Periods per topic	1/3	none
C	Periods per topic	1/2	none
D	Lessons per topic	1/5	none
E	Unit outline	1/7	none
F	Unit outline	1/5	none
G	Unit outline	2/3	none
H	Periods per topic	none	1/16
I	Unit outline + text chapter no.	1/3	1/9
J	Periods per topic-old program Unit outline-program under revision	2/9-1/5	none
K	Unit outline	1/4	none
L	Unit outline	1/5	none
	Average Percent Emphasis	28	1

[1] To maintain confidentiality outlines are identified by letter only. The outlines are from schools in the Scarborough, Peel, Toronto, North York, and York boards of education.

[2] The ratios listed are estimates of the relative amount of content which is covered with either a biochemistry or homeostasis emphasis.

[3] A rating of "none" means that there was no direct indication of the approach in the course outline.

[4] The conversion to average percent emphasis was done to yield comparable figures for Table 7 in the text.

APPENDIX TABLE 6

Guideline Unit Emphasis in Three Textbooks[1]

Content Area	Penny & Waern pages No.	%	Galbraith & Wilson pages No.	%	Moore *et al.* pages No.	%
Unit 1:						
Characteristics of Living Things						
1. Movement	1	<1	2	<1	ø	
2. Irritability	2	<1	2	<1	ø	
3. Reproduction	1	<1	2	<1	9	1
4. Metabolism	4	1	26	4	7	1
5. Added Category	58	7	51	7	71	9
6. Added Category	ø[2]		ø		56	7
Subtotals:	66	8	83	11	143	18
Unit 2:						
Cells						
1. Structure	38	4	23	3	13	2
2. Physical Properties	30	3	22	3	5	1
3. Mitosis	22	3	29	4	13	2
4. Added Category	88	10	8	1	23	3
5. Added Category	ø		ø		48	6
Subtotals:	178	20	82	11	102	14
Unit 3:						
Organisms						
1. Zoology						
1.1 Digestion	20	2	15	2	21	3
1.2 Circulation	21	2	17	2	13	2
1.3 Respiration	13	2	8	1	9	1
1.4 Excretion	11	1	11	2	8	1
1.5 Locomotion	32	4	22	3	12	2
1.6 Reproduction	14	2	20	3	41	5
1.7 Coordination	43	5	45	6	18	2
1.8 Added Category	35	4	60	8	38	5
Subtotals:	189	22	198	27	160	21

[1] Page numbers for each subtopic are available on request.

[2] ø is used to indicate that no pages emphasize that sub-unit.

APPENDIX TABLE 6 (continued)

Content Area	Penny & Waern pages No.	%	Galbraith & Wilson pages No.	%	Moore *et al.* pages No.	%
2. Botany						
2.1 Supporting System	23	3	18	3	2	<1
2.2 Anchorage	10	1	1	<1	2	<1
2.3 Absorption	4	<1	2	<1	2	<1
2.4 Conduction	2	<1	16	2	9	1
2.5 Growth	24	3	21	3	13	2
2.6 Gas Exchange	4	<1	2	<1	2	<1
2.7 Photosynthesis	13	2	5	1	17	2
2.8 Food Storage	5	1	1	1	2	<1
2.9 Reproduction	41	5	15	2	24	3
2.10 Coordination	10	1	15	2	5	1
2.11 Added Category	3	<1	56	8	3	1
Subtotal:	139	16	152	21	81	9
Unit 4:						
Classification						
1. History	12	1	9	1	1	<1
2. Principles	54	6	16	2	4	1
3. Use of Key	18	2	1	<1	ø	
Subtotal:	84	9	26	3	5	1
Unit 5:						
Interdependence						
1. Photosynthesis	19	2	14	2	15	2
2. Food Chain	16	2	4	1	9	1
3. Communities	ø		15	2	19	2
4. Population Size	8	1	10	1	26	3
5. Special Relationships	18	2	12	2	ø	
6. Influence of Man	ø		1	<1	16	2
7. Added Category	ø		20	3	15	2
Subtotal:	61	7	76	11	100	12
Unit 6:						
Heredity						
1. Reproduction	18	2	10	1	8	1
2. Meiosis	15	2	18	3	5	1
3. Added Category	36	4	20	3	69	9
Subtotal:	69	8	48	7	82	11

APPENDIX TABLE 6 (continued)

Content Area	Penny & Waern pages No.	%	Galbraith & Wilson pages No.	%	*Moore et al.* pages No.	%
Unit 7:						
Evolution						
1. Darwin's Theory and others	29	3	5	1	8	1
2. Mechanics	44	5	30	4	29	4
3. Application	ø		ø		ø	
4. Added Category	ø		12	2	69	9
Subtotal:	73	8	47	7	106	14
	859	100	712	100	779	100

APPENDIX TABLE 7

York University's View of the Aims of YUBAT[1]

Date	Source of Data	Aims
30.10.74	Memo from Dr. Davey to Dean D.R. Lundell	B.T.[2]: - providing information concerning standards of biology teachers in various schools - recognize and reward extraordinary student achievement in the absence of Ontario wide grade 13 examinations. Y.F.[3]: - improvement of the general visibility of York Science in the schools - identification of first class students, which, coupled to prizes which required attendance at York, should increase the intake of first class students at York.
18.12.74	Letter from Dr. Davey to G.D. Mitchell, head of Science, Chippewa Secondary School	Y.F.: - provide for greater uniformity of biology curricula in schools. - allow for exemption from parts of university courses of exceptional students.
2.1.75	Memo from Dr. Davey to test committee and Dean	B.T.: - Allow individual schools to assess their effectiveness in teaching certain areas in Biology. - provide recognition of outstanding achievement by individual students. Y.F.: - to be a tool for influencing the curriculum in Biology - serve to introduce some degree of uniformity among individual schools in their approach to the curriculum. - make it possible to excuse some exceptional students from University courses in Biology.
2.1.75	Memo of Dr. Davey to all academic staff of Biology Department	Y.F.: - serve to define the appropriate grade 13 curriculum in Biology - to be used as means of granting exemption from parts of Biology Department introductory program.
13.3.75	Letter from Dr. Davey to science teachers of Toronto, York, and Peel Counties	B.T.: - provide measure of student's achievement in Biology - measure of teachers' success in designing a course of study.

[1] Based on analysis of York University files.

[2] B.T.: = as seen by biology teachers involved in test construction.

[3] Y.F.: = as seen by biology faculty at York University.

APPENDIX TABLE 7 (continued)

Date	Source of Data	Aims
17.10.75	Letter from Dr. Davey to Mr. Canfield, President, STAO	B.T. & Y.F.: - improve communications between teachers and universities over the matter of the Biology curriculum.
17.6.75	Report on biology test by D. Farquhar	- The test would operate as a tool for improving uniformity of the curricula in Biology among individual schools. - The test might allow individual schools to assess their effectiveness in teaching in certain areas of Biology. - It would permit recognition of outstanding achievement by individual students. - Achievement on the test might be related to course requirements at the university level.
21.4.76	Suggested reply to Mr. Waldrum, by Dr. Davey	B.T.: - setting up a uniform set of standards against which Biology teachers could judge their own progress and success as teachers. - identify extraordinary achievement of students.
9.2.77	Note of meeting between representatives of York University and the Ministry of Education	B.T.: - recognize outstanding student achievement. - let teachers "know where they stand" in their Biology teaching.
22.7.77	Note of meeting between representatives of York University and investigators.	B.T.: - Help teachers assess their own effectiveness in teaching Biology. - Permit recognition of outstanding achievement by students. Y.F.: - Provide for some liaison between the University and high schools.

Appendix C

CALCULATION OF SELECTED CONTENT EMPHASES IN REPRESENTATIVE TEXTBOOKS

The calculation of values for five of the six selected content emphases in textbooks was estimated on the basis of Appendix Table 6. Scientific methodology was rated according to a high, medium or low emphasis based on each book's overall direct treatment of inquiry, its explorations and interpretations of knowledge statements and, to a limited extent, its chapter end questions to students. All values are to be seen as approximate only since direct page counts for each of the selected content emphases were not made. It is assumed that the calculated figures are sufficiently reliable for purposes of the comparisons made in this study.

Penny and Waern

Five selected content emphases are calculated in the following Appendix Table. The sixth is explained immediately after the table.

APPENDIX TABLE 8

Five Selected Content Emphases in Penny and Waern

Content Emphasis	Content Area	Percentage of Total Pages
Biochemistry	Unit 1: Added category	7
	Unit 2: part of Added category	9
	Unit 3: (Zoology)	
	: part of Circulation	1
	: part of Respiration	1
	: Coordination	5
	: (Botany)	
	: Photosynthesis	2
	Unit 6: Added category	4
	Total:	29
Zoology Botany ratio	Unit 3: (Zoology)	
	: Digestion	2
	: Circulation	2
	: Respiration	2
	: Excretion	1
	: Locomotion	4
	: Reproduction	2
	: Coordination	5
	: Added category	4
	Unit 4: part of Classification	2
	Total:	24

APPENDIX TABLE 8 (continued)

Content Emphasis	Content Area	Percentage of Total Pages
Zoology Botany ratio	Unit 3: (Botany)	
	: Supporting system	3
	: Anchorage	1
	: Absorption	1
	: Growth	3
	: Gas exchange	1
	: Photosynthesis	2
	: Food storage	1
	: Reproduction	5
	: Coordination	1
	Unit 4: part of Classification	4
	Total:	22
Genetics	Unit 6: Reproduction	2
	: Meiosis	2
	: Added category	4
	Total:	8
Ecology	Unit 5: Photosynthesis	2
	: Food chain	2
	: Population size	1
	: Special relationships	2
	Total:	7
Homeostasis	Unit 3: (Zoology)	
	: part of Added category	1
	: (Botany)	
	: Coordination	1
	Total:	2

Scientific Methodology: The text is written mainly in an informative manner, imparting a body of scientific knowledge without commenting on the ways and means of arriving at this knowledge. However, there are sections which stress the uncertainty of knowledge as, on p.143: "There is, however, no consistent evidence that membranes and vesicles of the Golgi bodies are in fact continuous with those of the endoplasmic reticulum." And "Other writers consider the mitochondria to be centres of membrane production." Microscopy is explained (pp. 111-117) and some history of biology is included. For instance, the ideas of species and the work of Linnaeus (pp. 613-625). On balance it was decided that scientific methodology tended not to be emphasized and the text was rated "low emphasis" for this content emphasis.

Galbraith and Wilson

Five selected content emphases are calculated in the following Appendix Table. The sixth is explained immediately after the table.

APPENDIX TABLE 9

Five Selected Content Emphases in Galbraith and Wilson

Content Emphasis	Content Area		Percentage of Total Pages
Biochemistry	Unit 1:	Metabolism	4
		Added category	7
	Unit 3:	(Zoology)	
	:	part of Added category	3
	:	(Botany)	
	:	Photosynthesis	1
	:	part of Added category	4
	Unit 6:	Added category	3
		Total:	22
Zoology Botany ratio	Unit 3:	(Zoology)	
	:	Digestion	2
	:	Circulation	2
	:	Respiration	1
	:	Excretion	2
	:	Locomotion	3
	:	Reproduction	3
	:	Coordination	6
	:	Added category	8
		Total:	27
	Unit 3:	(Botany)	
	:	Supporting system	3
	:	Conduction	2
	:	Growth	3
	:	Photosynthesis	1
	:	Reproduction	2
	:	Coordination	2
	:	Added category	8
		Total:	21
Genetics	Unit 6:	Reproduction	1
	:	Meiosis	3
	:	Added category	3
		Total:	7

APPENDIX TABLE 9 (continued)

Content Emphasis	Content Area		Percentage of Total Pages
Ecology	Unit 5: Photosynthesis		2
	: Food chain		1
	: Communities		2
	: Population size		1
	: Special relationships		2
	: Physical environment		3
		Total:	11
Homeostasis	Unit 3: (Zoology)		
	: part of Coordination		2
		Total:	2

Scientific Methodology: Galbraith and Wilson deal explicitly with the principles and history of inquiry. Two examples are pp. 406-415 on classification and pp. 382-395 dealing with tropism. This text appears to provide teachers and students with many opportunities to deal with the nature of inquiry and the development of science, as required in the Biology curriculum guideline.[1] The book reflects a philosophy of science teaching which stresses the events leading to scientific knowledge, as well as the explanatory power and limitations of scientific concepts. For example, DNA is first discussed as a phenomenon and then the discussion is interpreted in terms of genetic principles (p.641). In another instance, the text points out the historical relationship among four geneticists: "De Vries in the Netherlands, Correns in Germany and Tschermak in Austria reported results of their studies in inheritance in 1900, each calling attention to Mendel's paper 34 years earlier and reaffirming the conclusion that characteristics are due to transmission of discrete heredity factors." (p.643). An example of the limitations of scientific concepts is that "No one has ever seen a gene, and few geneticists can accurately define the gene." (p.656). On balance it was decided that scientific methodology was "moderately" emphasized in Galbraith and Wilson.

Moore et al.

Five selected content emphases are calculated in the following Appendix Table. The sixth is explained immediately after the table.

[1] Ontario Department of Education, *Biology: Grade 13*, p.1.

APPENDIX TABLE 10

Five Selected Content Emphases in Moore *et al.*

Content Emphasis	Content Area	Percentage of Total Pages
Biochemistry	Unit 1: Metabolism	1
	: Added category	9
	Unit 2: Microorganisms	3
	Unit 3: (Zoology)	
	: part of Digestion	2
	: part of Respiration	
	: part of Excretion	
	: part of Reproduction	
	: part of Coordination	
	: (Botany)	
	: Coordination	1
	Unit 5: Photosynthesis	2
	: part of Added category	1
	Total:	19
Zoology Botany Ratio	Unit 3: (Zoology)	
	: Digestion	3
	: Circulation	2
	: Respiration	1
	: Excretion	1
	: Locomotion	2
	: Reproduction	5
	: Coordination	2
	: Added category	5
	Total:	21
	Unit 3: (Botany)	
	: Conduction	1
	: Growth	2
	: Photosynthesis	2
	: Reproduction	3
	: Coordination	1
	Total:	9
Genetics	Unit 6: Reproduction	1
	: Mitosis	1
	: Added category	9
	Total:	11

APPENDIX TABLE 10 (continued)

Content Emphasis	Content Area	Percentage of Total Pages
Ecology	Unit 5: Photosynthesis	2
	: Food chain	1
	: Communities	2
	: Population size	3
	: Influence of man	2
	: Physical environment	2
	Total:	12
Homeostasis	Unit 3: (Zoology)	
	: part of Circulation	
	: part of Coordination	1
	: part of Added category	
	Total:	1

Scientific Methodology: The Moore *et al.* textbook reflects a commitment to deal with the processes of scientific inquiry and to involve students in inquiry. The questions and problems at the end of each chapter, as well as the suggestions for related reading, aim at encouraging individual learning activities. Frequently, however, the questions are recall questions, and not invitations for inquiry; for instance p. 335: "What is a seed? a fruit?"; "What was Went's technique for measuring the relative amount of auxin?" Yet the book is written in the form of narrative of inquiry and attempts to transmit a spirit of scientific curiosity, for example, chapters 1-4. Various steps in scientific experimentation are explained and exemplified, and the book provides teachers and students with the opportunity to acquire an "inside" view of the biological sciences. On balance it was decided that the Moore *et al.* textbook had a "high" emphasis on scientific methodology.